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The paths of the policies and measures taken by the Chinese government for strengthening basic research and improving research managements

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Executive Summary

The paths of the policies and measures taken by the Chinese government for strengthening basic research and improving research managements

The purpose of this study is to weigh the Chinese government's measures for promotion of basic research in its current system, the reform of scientific research management, and their effects on the development of innovation.

China's investment in R&D, the number of papers and their citations, the number of patent applications, etc., are all rising steadily, and one can see that China is approaching and even surpassing the United States in some cases. On the other hand, a completely different picture from this momentum can be seen in China's recent trade balance related to intellectual property, where the deficit has been widening. Understanding this situation, one motivation for this study is to investigate some underlying factors in the flow from basic research to innovation activities in China.

First, we have to recognize that the definition of basic research in China differs from that in the Frascati/Manual, and that its party line documents consistently and strongly encouraged "basic research for application." The texts produced by the Communist Party are carefully constructed based on the history and context of the Party's leadership, and not surprisingly, "application-oriented basic research" is consistently and strongly recommended repeatedly in almost all relevant documents, which in a sense is not an exaggeration to say that it is being forced upon researchers.

Considering R&D policies in other countries, this Chinese policy may hardly lead to innovation. This report discusses the problematic aspects of the "applied" orientation of basic research, referring to the policy content and development in Europe, the U.S., and Japan. In particular, recent research and development policies such as the EU's emphasizing on mission-oriented research, and the strengthening of the innovation path, as represented by the creation of the NSF/TIP, which focuses on securing the technological leadership of the U.S., are likely to make China reaffirm the correctness of its own path. In fact, this choice of Western path is surely based on the significant investment in basic research in the U.S. and Europe and is different from the continued pursuit of an application-oriented approach in basic research. This is not to say that China's emphasis on application oriented basic research produces nothing. It is however noted here that without proportional efforts in basic research, the broad base for creating innovation is not there.

Since the Xi Jinping administration came to power, China has established and implemented aggressively policies of strengthening basic research through a series of policy documents issued by the Party Central Committee, the State Council, and other administrative agencies. This report also reviews the process of formulating these policy documents as well as their contents.

China's investment in basic research is relatively poor compared to Japan, the U.S., and Europe. If, as noted above, Chinese basic research includes "application-oriented basic research," investment in "pure basic research" must be considered quite low. The Chinese government knows it well and is aiming to increase this ratio in coming years. Given China's current financial strength, it can be easy to do. The question, however, is whether the basic research that will receive increased investment will be really "basic research based on free thinking," or whether it will remain application-oriented one in nature. The outcome of this choice will differ seriously. It remains to be seen whether the Party's guidance in the 14th Five-Year Plan, that is, "New Direction - Freedom in Science," which is in a sense inconsistent with the current policy of strongly pushing application oriented basic research, would change Party

center's perception into the one that a broad, diverse, and free basic research could lead to innovation.

The reason for taking up policies related to the promotion of basic research and the reform of the management of scientific research institutes is that basic research should be by design based on free ideas that are not bound by applications, and that to achieve this freedom, research management policies including those relating to the use of research funds, flexibility in recruiting human resources, and scientific evaluation methods, should be implemented so that the performance of research must be privileged first. We therefore decided to conduct this study because we believe that analyzing China's research system in line with the above-said aspects is one way to determine whether China's research system is suitable for creating innovation.

As part of its science and technology innovation policy, the Xi Jinping administration has also adopted a novel policy of reforming its "scientific research management". This reform is extremely important for improving the efficiency of the research field as a whole and is particularly noteworthy as part of a strategy to strengthen basic research, which requires free thinking.

The institute has been reforming its research management systems through the use of symbolic slogans, such as "放管服 (phan guan hu) " to improve services by delegating authority to research labos, "包干制 (bao gan ji) " system, which increased flexibility and researcher autonomy by placing as few restrictions as possible on the percentage of expenses and their use, and the abolition of the "四唯 (su wei) " system, which placed emphasis on only four nominal achievements, including titles and academic credentials. "揭榜挂帥(je ban gua swei)," which focuses on researchers who are capable of carrying out projects, and "賽馬 (sai ma) ", which encourages young researchers to compete, as well as a negative list to clarify what is not allowed. Reforms also include increasing the authority of project leaders in deciding technological paths, enlarging the proportion of indirect costs as well as allowing incentives for participating researchers to be paid out of those costs. In the evaluation process, emphasis has been placed on scientific value, and so-called peer review by small group of scientists is being more encouraged, and there have even been moves to introduce market evaluations. It ranges from funding of the National Natural Science Foundation of China (NSFC) to national science and technology programs in general.

Researchers have given a favorable evaluation of these reforms in science and technology management, and a questionnaire survey shows that they welcome the increased freedom in the use of expenses and the elimination of the old methods of hiring by nepotism and human relations. On the other hand, the Chinese Academy of Sciences' policy that "50% of managers must be under 40 years of age" is very typical of the current situation in China where the uniform policies can be nationally enforced. We cannot take our eyes off the reforms.

It remains to be seen how the various reforms implemented by the Xi Jinping administration will affect China's research system, but this study has identified several points of view that need to be followed up.

The first one is the research results, i.e. the papers. Although there is a problem that the actual situation cannot always be grasped well due to the different definitions of basic research mentioned above, it is crucial, it is not easy though, to follow the flow of how the results of basic research are transferred to the field of innovation. There are statistics showing that the number of Chinese papers has been approaching that of the U.S. and has already surpassed the U.S. in the number of citations, but we believe that the methods of quantitative and qualitative analysis of Chinese research papers should be further devised for getting a better picture of the actual situation in China. In doing so, it will be vital to understand the organizational and institutional structures surrounding Chinese researchers.

Scientific journals reflect the state of science. Chinese scientific journals operate within their own publication management frameworks, but depend on Western publishing systems or custom for international development.

However, China is also aiming to publish and expand its own leading international journals, and is encouraging researchers to increase their submissions to Chinese (language) journals. The editorial methods of scientific journals are quite different from those in the West, and it is not always easy to evaluate them, but at least China itself seems to be taking the initiative in creating the institutional infrastructure of scientific journals, and is seeking to gain hegemony over them.

The way in which R&D funding, such as institutional support and competitive funding, is provided provides maximum stimulus to the power of the research frontline, and is a powerful factor in effecting structural change. The above-mentioned reforms in the management of scientific research institutes also extend to domestic funding systems such as NSFC in terms of the use of research funds and the allocation of indirect costs. The reforms seem to have been made after China's considerable study of the funding systems in Europe and the U.S., especially the U.S. NIH and NSF. From the perspective of allowing researchers to flexibly achieve their research objectives, these reforms mostly follow the Western systems, and their effectiveness in China must be paid attention. We believe that there would be some in which Japan should also be interested.

As China seeks to strengthen its basic research and reforms its management of scientific research, how can we answer the question posed at the beginning of this report? The information so far available to date organizes the answers as follows.

Whether it is academic freedom or freedom of scientific research, the starting point for all is the institutional settings for researchers particularly in choosing their research agenda without any constraints. If this fundamental issue is not understood, researchers will not be able to enjoy a sense of academic openness and will not effectively work, no matter what documents are issued. It does not seem at all that the issue of "freedom of scientific research" is currently being actively taken up in China, and in a situation in which exhaustive discussion of "freedom" is incompatible with the idea of "Party's leadership," the Party is well aware that the issue of "freedom" in general is a double-edged sword, and it is likely to secure "freedom" that leads to innovation at the very last moment.

In addition to "freedom," this study also examines "classification and evaluation," "degree of organizational involvement," and "research integrity or fairness and punishment," which are important aspects that differ from those in Japan, the U.S., and Europe, and looks at their negative impacts on the research sphere. Although it depends on the extent to which Chinese researchers view these issues as problems in the conduct of their own research, we believe it is essential to at least recognize that these issues exist in the Chinese research system.

The recent escalation of the U.S.-China conflict has had a profound impact on the nature of international cooperation to date. In particular, Western countries are under pressure to devise novel measures to maintain and develop open international cooperation while securing leadership in emerging and critical technologies against China and other competing countries that seek to exert national influence. China, on the other hand, has moved away from its past dependence on Western universities and research organizations, particularly in the U.S., for training young researchers, and has begun to strengthen its domestic training programs, and is taking various measures to become a center for continuing to attract global younger talents to further enhance its own potential for advanced research and development. It is also necessary to pay close attention to what new phase China's "activities" challenging the existing institutional infrastructure of science and technology will bring about, such as strengthening its own international journals, taking the initiative in international conferences and research gatherings, and the still unclear concept of a "World Science and Technology Fund". In addition, Russia's invasion of Ukraine is a serious challenge to the international agreement to unilaterally change the status quo by force, and it has developed into a serious problem that involves the world scientific community as well as questions the ideology of researchers regarding the nature of international cooperation. There is a sense that the attitude of individual researchers toward such challenges may be considered a prerequisite for a basic agreement on international cooperation.

We will need to analyze and evaluate China’s science and technology from a different perspective than the quantitative development-oriented evaluations of the past. In doing so, we will need to collect relevant information in China on various aspects of R&D activities, and refer to the views of countries with diverse values, in order to explore options for pursuing Japan’s national interests in cooperation with likeminded countries. We believe that by doing so, we may be able to identify more concrete measures to pursue policies related to the economic security of Japan, the West, and the United States. In the future, when we engage in international cooperation with China in the field of basic research, we need to recognize that such basic research is strongly oriented toward application, based on the basic premise of military-civilian fusion. We hope that this study will serve as an opportunity for this purpose.

What we have observed and expressed in this report can be seen as a kind of advice to China. If China, for example, fully understands the meaning of the points made in this report and takes it as a reference, and if it promotes basic research based on the same ideas of freedom as we have, it would be able to promote research with originality leading to innovation.

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Foreword: Why Focus on Basic Research Promotion and Scientific Research Management Reform?

The human work of making new discoveries and inventions by accumulating new knowledge over the intellectual heritage of the past should be a universal activity common to all human beings as long as no differences in people's biological are been proven[1]. However, the fact that the United Kingdom attracts promising students and young researchers with strong basic research capabilities and the United States has a remarkably developed venture capital and excels in innovation, or the fact that France has been unable to prevent excessive state control of research, are due to the effects of the political, economic, and social institutions and frameworks of each country on this activity. Western research systems cannot be introduced directly into Japan as these effects must be fully taken into consideration. Thus, it is important to find the "key" to these effects.

Although various surveys of overseas trends have been conducted, it has been difficult to find such a key. This may be because finding it requires a keen eye and an approach that, after recognizing the differences between Japan and other countries, can abstract and generalize the path to that key, translate it to a form that suits Japan, and fit it into reality.

While researchers' interest is to quickly test their own ideas for research projects, this may require good research partners, timely financial support, freely available research funds, promising young researchers, up-to-date research equipment and facilities, meticulous and skilled technicians, administrative assistants to take care of clerical work, and more. The financial and human resource frameworks necessary to obtain these assets are set up in each country as the concrete institutions of research systems. In China, such management of science and technology and research and development (R&D) is called "scientific research management."

In recent years, the Xi Jinping administration, in particular, has made strenuous efforts to promote basic research and reform scientific research management. Both aspects are crucial in finding the key mentioned above. The reason why this report focuses on policies related to basic research promotion and scientific research management is that basic research should stem from free ideas that are not bound by applications and that to achieve this freedom, policies should be implemented that prioritize the performance of research in various aspects of scientific research management, including the use of research funds, flexibility in recruiting personnel, and scientific standards of evaluation. It is our belief that analyzing the Chinese research system in terms of the content and realities of these two policies will uncover the key to this system and contribute to determine whether this system fosters innovation.

Thus far, Japan has mainly studied and attempted to adopt Western research systems, especially that of the U.S. However, it is difficult to incorporate such a system into a context where the fundamental conditions are different. No matter how much Japan clamors about DARPA (the U.S. Defense Advanced Research Projects Agency), it cannot imitate its strengths. The Chinese authorities must also be studying the research systems of other countries very

1 The history of reflection on how anthropology, which flourished at the end of the 19th century and included anatomy and craniology, led to subsequent racial discrimination is detailed in Kanno Kenji's "Science in the Dreyfus Affair" (2002, Seidosha). Needless to say, this report does not support proving differences in human biological abilities.

closely and in depth. In fact, the Japan Science and Technology Agency (JST) seems to be one of the institutions that have been thoroughly researched and studied.

As mentioned above, if we consider research as an arena of universal human activity regardless of a country's political, economic, and social institutions, it is natural to expect that China will achieve results on par with the United Kingdom and the U.S. by adopting key elements of Western research systems. In fact, the elements of the Xi Jinping administration's reforms discussed in this report at least closely capture the characteristics of Western research systems. However, it is also the purpose of this report to analyze how such reforms can be used to demonstrate innovation.

Previous research has discussed whether world-leading creative scientific progress and high-quality, breakthrough innovations can be produced even in a socialist market economy and a Communist Party-led state. There is no doubt that science can progress and lead to innovation regardless of political, economic, and social systems, as long as the institutions related to science and technology successfully stimulate research activities. However, since the people who conduct the research and the circumstances under which these people are placed are also important, the impact of involvement of the state's intention and management on them must also be considered.

The U.S.-China conflict is expected to create a different environment for research trends and international cooperation between the two countries and will have various effects on the individual behavior of researchers. The new perspective on China pursued in this research report is not only to analyze and evaluate various aspects of Chinese science and technology and R&D in terms of quantitative expansion but also to collect relevant information from China from multiple perspectives and to explore options for pursuing Japan's national interests in cooperation with friendly countries, while also considering the views of countries with diverse values. It is our hope that this new perspective on China's view of scientific and technological innovation will contribute to form the basis for individual judgments about the state of China's development and the nature of international cooperation with China.

In this report, Chapter 1 describes the current status and problems of basic research, Chapter 2 follows policy transitions in connection with the reforms enacted by the Xi Jinping administration, Chapter 3 reviews the funding and perceptions of basic research, and Chapter 4 addresses journals and papers that can be considered the results of basic research and scientific research management. Chapter 5 touches on the basic structure of funding institutions and their reform. Finally, Chapters 6 and 7 discuss the advantages and challenges of the Chinese research system and how it differs from those of Japan, the U.S., and Europe, as well as the future of the Xi Jinping administration's efforts to promote basic research and reform scientific research management.

Since this report covers a wide range of topics in detail, after reading the Foreword, those who wish to gain a concise understanding of specific topics should read sections 2.10 and 2.11 on basic research promotion and scientific research management reform, sections 5.5 on the reform of funding institutions, section 5.6 on specific comparisons with Europe and the U.S, and Chapters 6 and 7, respectively, for information on the advantages and challenges of China's research system and its different environment from that of the West, as well as the Conclusion.

1 Definition of Basic Research and Policy Positioning

1.1 Causes of unoriginal basic research in China: Insights from previous studies

China has made remarkable progress in scientific and technological innovation in recent years, and few experts would doubt that the country's achievements are linked to its rapid socioeconomic development. China's investment in R&D, number of papers and their citations, number of patent applications[2], and other statistical figures indicating an upward trend have been announced one after the next, demonstrating that China is closing in on and even surpassing the U.S. in some areas. In stark contrast to this momentum, China's trade balance of intellectual property has experienced a widening deficit in recent years. It is also true that Chinese government officials themselves are not always confident that China's economic progress is supported by the innovations the country has produced[3]. The causes of this situation may lie in the flow from basic research to innovation in China.

What have previous studies revealed to suggest such causes?

First, let us look at the points raised from the perspective of science and technology policy. Experts in this field in Japan have long pointed out the weakness of basic research in China. As early as July 2003, Sunami Atsushi, who had conducted an analysis and evaluation of enterprises operated by Chinese universities, pointed to problems with China's strategy of promoting university reforms that introduced the principle of competition with the aim of realizing "a country of science and education" and encouraging "university-affiliated enterprises" established by universities using the results of their research. Sunami stated, "The transition to a market economy is making it difficult to provide research funding to basic research fields that are unlikely to generate short-term profits. Concerns that long-term basic research will be curtailed threaten the comparative advantage that university research already has in this area[4]."

Isa Shin'ichi notes that "the low efficiency of investment in basic research is an issue that needs to be tackled in order to achieve China's national vision" and describes this as an "investment structure that hinders innovation." He asserts that "at its core, innovation means to bring about major changes in society by drastically transforming established concepts and existing values. Therefore, innovation is not obtained through applied research to solve ongoing problems or development research for the purpose of practical application[5]." According to Isa, "there is no

2 According to China Science and Technology Statistics 2022 (JST), China's total import and export value of "high-tech products" was about USD 13.7 billion in 2019 (USD 14.2 billion in 2018), and export trade was USD 7.3 billion in 2019 (USD 7.4 billion in 2018). However, according to materials compiled from World Bank data, courtesy of the JST Beijing Office, China's intellectual property trade balance was USD −35.1 billion in 2021, with a USD 5.8 billion decrease from 2020, and has been increasingly negative for the past 10 years.

3 The prevailing rhetoric of successive Chinese government documents has been to laud the progress of innovation in China while arguing that it has not yet produced sufficient results or effectively solved socioeconomic issues. This duality has always existed and has inspired scientific research institutions and researchers.

4 Sunami Atsushi, National Graduate Institute for Policy Studies, "Industry-University Cooperation and University-affiliated Enterprises in China" p. 9., RIETI Discussion Paper Series 04-J-026,https://www.rieti.go.jp/jp/publications/dp/ 04j026.pdf (accessed January 29, 2022)

5 Isa Shin'ichi, "'Science and Technology Superpower': The Truth about China," Kodansha Gendai Shinsho, October 2010, pp. 82-85

doubt that the degree to which political agendas affect academic and research freedom varies according to the political system of a country. The more the direction of research in Chinese science and technology is determined from a political perspective, the more development will be hindered[6].” Isa further argues that innovation “will never be tolerated if it leads to regime change.”

Hayashi Yukihide also mentions a “lack of originality” and argues that “in China, a country that has existed for a very short period of time since the Cultural Revolution, the accumulation of academic and basic research is probably not yet sufficient to support originality[7].” In his recent book describing the characteristics and challenges of Chinese science, technology, research, and development, Hayashi also identifies lack of originality as a problem in Chinese life sciences[8]. However, as seen in the Report on the Work of the Government of the 5th Session of the 12th National People’s Congress on March 5, 2017, the Chinese government has already recognized the importance of this issue, which was addressed in the 2018 and 2020 policy documents presented in Section 2.5.

In the same book, Hayashi also mentions China’s successful experience in developing military technology as a background factor of the issue[9]. He states, “Nevertheless, it can be considered a problem that time will solve, and it is expected that a number of studies will emerge in the not-too-distant future and will be recognized as original by CAS [author’s note: Chinese Academy of Sciences].” However, Hayashi does not explain why he considers this only a matter of time. He also states that “China should be neither feared nor underestimated.” The problem is to know well what to fear and what the limits are without underestimating it. He concludes, “We should face China head-on and as-is, , and seek mutual peace and prosperity while maintaining equal relations[10].” This discourse was echoed in the 2000s by Kuroda Atsuo, who stated, “Japanese companies should take advantage of China’s increasing production capacity and growth potential. (...) They have many ways to take advantage of China’s industrial base without having to expand into the country themselves. Not only individual companies, but the Japanese economy as a whole must take advantage of China’s production capacity and market. Most importantly, China’s presence should be used as a catalyst to make Japan a more open and competitive country in order to compete with China, which has become a fiercely competitive society[11].” This is in line with the argument that Japan should tap into China’s growth potential.

Science journalist Kurasawa Haruo states that “truly original research is still scarce because the tradition of basic research was disrupted by events such as the Cultural Revolution. Since basic research involves a long and difficult maturation period, it is important to be able to set up a research system that is not focused solely on short-term achievements.” He further states that “The current situation where research that is not in line with government policy is disregarded is detrimental to basic research. R&D investment is concentrated in engineering and applied fields that generate practical benefits, and there is still little emphasis on basic research[12].” Kurasawa notes that the government’s emphasis on and investment in basic research is a challenge because of the “breakdown of the tradition of basic

6 Isa Shin’ichi, *op. cit.,* p. 191

7 Hayashi Yukihide, “The Chinese Academy of Sciences - The Full Story of the World’s Largest Science and Technology Organization: Excellence and Challenges,” Maruzen Planet, October 2017, pp. 173-174

8 Hayashi Yukihide, “Life Science Research in China,” Life Science Foundation, April 2020, p. 188.

9 Hayashi Yukihide, *ibid.,* p. 175.

10 Hayashi Yukihide, “China as a Science and Technology Superpower: From Manned Space Flight to Nuclear Power and iPS Cells,” Chuokoron Shinsho 2225, July 25, 2013, p. 184.

11 Kuroda Atsuo, “Made in China,” Toyo Keizai, November 2001, p. 287

12 Kurasawa Haruo, “China’s ambitions for science, technology, and hegemony,” Chuokoron Shinsho Rakule 691, June 10, 2020, p. 184.

research" and "investment focused on practical benefits." This report will analyze this situation, tracing it back to the government's approach itself.

How has China been regarded from an economic perspective? Economist Kajitani Kai states, "In order for those of us living in Japan to properly understand the Chinese innovations that have been gaining attention in recent years, we need to focus on the relationship between the private enterprises that are leading the way and the authoritarian political system. (...) Conventional mainstream economics holds that innovation based on free ideas is also unsustainable under an authoritarian regime in which freedom of speech is suppressed[13]." Undoubtedly, the power to create true innovation has its source in original basic research. Therefore, to further expand on Kajitani's point, the current political system in China will not allow for the promotion of original basic research, no matter how many reforms are implemented. Kajitani further states that "Acemoğlu and Robinson[14] call the institutions that promote innovation and economic growth as 'inclusive institutions' and that 'inclusive institutions' can be divided into 'inclusive political institutions represented by parliamentary democracy' and 'inclusive economic institutions represented by a free and fair market economy[15].'" He continues, "To summarize these mainstream arguments, China lacks free speech, property rights, and a legal system that guarantees the sustainability of innovation, especially intellectual property rights." "However, the Chinese government is well aware of these criticisms. This is why, in recent years, the government has been focusing on policies to protect intellectual property rights, and in 2008, it released the Outline of the National Intellectual Property Strategy, which clarified its policy to significantly raise the level of intellectual property rights protection[16]." Kajitani implies that we must look closely at what aspects of the institutional infrastructures built by Japan, the U.S., and Europe China is adopting or reforming.

Among the theories that have emerged regarding Chinese innovation are the "heterodox innovation theory" and the "Chinese heterodox theory," which are rooted in the relationship between innovation and political and social regimes, such as authoritarianism and suppression of freedom.

Ito Asei poses the following problem: "Chinese companies are releasing new products and services, and major cities in China are becoming R&D centers, but this seems to be an 'unexpected' event for many. First, we do not expect innovation to occur in developing and emerging countries. Second, we do not expect innovation to occur in so-called authoritarian regimes." Ito also notes the relationship with the authoritarian regime "in which the role of state intervention is particularly significant[17]." This suggests that there is a need to look specifically at the relationships between the system of governance and the basic research examined in this report, particularly the role of state intervention, and that it is meaningful to examine this point in depth.

In the same book, Kawashima Shin identifies freedom as an important factor, noting that "there are questions as to whether technological innovation in China is dependent on others — merely 'applying' technology developed abroad

13 Kajitani Kai, "Lecture on China's Economy: From the Reliability of Statistics to the Future of Growth," Chugoku Koshinsho, September 2018, p. 249

14 In *Why Nations Fail*, Daron Acemoğlu and James A. Robinson argue that the ability of a nation or society to achieve sustainable economic growth depends on whether its institutional framework is "extractive" or, at the opposite end of the spectrum, "inclusive."

15 Kajitani Kai, *ibid.,* p. 192

16 Kajitani Kai, *ibid.,* p. 194

17 Ito Asei, Chapter 4, "Problems Posed by Chinese Enterprises for Innovation," in Kawashima Shin, The 21st Century Public Policy Institute ed., "Three Elements for Understanding Contemporary China: Economy, Technology, and International Relations," August 25, 2020, Keiso Shobo, p. 109

— or whether it can be created independently, and whether innovation is possible at all in an emerging country, and in a socialist country under an authoritarian regime where "freedom" is considered to be non-existent[18]."

In "Chapter 5: A study of innovation in China and future direction," Amemiya Kanji attributes the cause to strict surveillance. He states that "in China, the creation of ideas has been severely curtailed by strict thought control and surveillance by the party and government in all processes of idea creation, consumption, and dissemination, from educational institutions to the media[19]." Amemiya further states that "a key issue will be whether China can indeed acquire new, discontinuous forms of innovation[20]." Both Ito and Amemiya mention the growth and extent of China's R&D investment, the relatively large amount spent on universities and public institutions, and particularly the small amount invested in basic research. Notably, analyses by trading and banking research organizations[21] often assess the vitality of China's innovation activities, which are pursued by mobilizing all levels of local government, scientific research institutions, universities, and state-owned enterprises while investing vast amounts of public funds in accordance with national plans formulated by the Chinese government.

What are the international views on the matter? We will address those that seem representative over time. As early March 2014, shortly after the Xi Jinping administration came to power, Regina M. Abrami et al. commented that "the innovative or intellectual capacity of the Chinese people (...) is boundless, but the political world in which their schools, universities, and businesses need to operate (...) is very much bounded," since the Communist Party organization had penetrated every corner of the Chinese social system, casting strong doubt on the emergence of the entrepreneurial spirit advocated by Joseph Schumpeter[22]. In 2020, Richard P. Suttmeier made the rather accurate point that although China's originally had a tradition of basic research, its increased budget was being diverted by application-oriented motifs[23]. Emily Weinstein, in Tech Stream, January 6, 2022, discusses China's innovation policy, stating that although U.S. policymakers tend to believe that "only democracy can promote innovation," they are gradually moving away from the idea that "non-free market countries cannot innovate" in light of recent reforms in China[24]. Since the Xi Jinping administration came to power, the emphasis seems to have shifted from the view that the limitations of scientific and technological activities under the Communist Party regime were the cause of the lack of innovation to an analysis of background factors and further to the view that recent reforms may lead to innovation even in a socialist market economy. In June 2021, Jin Chen et al. discussed how China could become an innovation

18 Kawashima Shin, *ibid.,* p. 19

19 Amemiya Kanji, Chapter 5 "A study of innovation in China and future direction," *ibid.,* p. 149.

20 Amemiya Kanji, *ibid.,* p. 33

21 As a representative example, see "Mizuho Research & Technology Consulting Report vol. 1 2021, Japan-China Comparison of Innovation Environment and New Developments in Japanese Innovation Policy, Consulting Part 2, Honda Kazuhiro, Researcher; Kubo Hisashi, Senior Researcher; Ogawa Takuya, Researcher", https://www. mizuho-ir.co.jp/publication/report/2021/pdf/mhrt01_innovation.pdf (accessed May 4, 2022).

22 Regina M. Abrami, William C. Kirby, and F. Warren McFarlan, "Why China Can't Innovate," Harvard Business Review, March 2014, https://hbr.org/2014/03/why-china-cant-innovate (accessed April 10, 2022)

23 Richard P. Suttmeier, "Chinese Science Policy at a Crossroads", ISSUES IN SCIENCE AND TECHNOLOGY, VOL. XXXVI, NO. 2, WINTER 2020, National Academies of Sciences, Engineering, and Medicine and Arizona State University. https://issues.org/chinese-science-policy-at-a-crossroads/#:~:text=US%20efforts%20to%20decouple%20from,challenges%20for%20 Chinese%20scientific%20development. (accessed April 21, 2022)

24 Emily Weinstein, "Beijing's 're-innovation' strategy is key element of U.S.-China competition," Tech Stream, January 6, 2022, https://www. brookings.edu/techstream/beijings-re-innovation-strategy-is-key- element-of-u-s-china-competition/ (accessed April 21, 2022)

powerhouse from the perspective of "holistic innovation[25]," fully recognizing the challenge of "finding new sources of innovation and growth" while expressing confidence that China has a wealth of practical experience in promoting "mission-oriented" research, which requires a balance between "public guidance (author's note: the Communist Party's central leadership) and market forces." This is the "organic unification of the role of the market and the role of the government" advocated by General Secretary Xi Jinping. This article recognizes the importance of "basic research" but asserts that only the guidance of the Communist Party's central leadership can pave the way for China to become an "innovation powerhouse." This confidence aside, China's weakness and tendency to lag behind the U.S. when it comes to basic research are clearly confirmed in the final conclusion of the latest *Oxford Handbook of China Innovation*[26]. The authors are correct in their assessment that rather than R&D activities per se, China's "global competitiveness" is enhanced by the "Chinese innovation ecosystem, that is, hundreds of millions of overly receptive and adaptable consumers[27]." Once basic research has reached the stage where it can effectively produce results, this "consumer power" will probably be a factor that other countries will not be able to imitate.

With little information available and only an uncertain perception of the current state of Chinese society, the points made by Isa and Hayashi are persuasive as views of China's capabilities from the perspective of science and technology administrators who have witnessed the situation firsthand. The points made by Kajitani, Ito, and Amemiya are also understandable as opinions from the mainstream of economics. These findings in previous studies certainly suggest that there is a problem with the way basic research, which is the source of innovation, is conducted in China, and furthermore, that it is worthwhile to examine in depth the background and causes of such a problem. We posed the question of why the promotion of basic research, which by nature demands free ideas, does not lead to innovation under China's system of governance, that is, an authoritarian regime. In this report, we hope to fill in the gaps in the process leading to the answer to this question. In the following sections, we will first define basic research and then take a closer look at the current status of its reform.

China has also thoroughly studied the science and technology innovation policies and research systems of Japan, the U.S., and Europe and implemented various reforms to create institutions that incorporate these policies and systems in China's own way. These reforms can naturally be expected to have certain effects; the key question is whether these effects will come to fruition. The trajectory of China's efforts will be covered in this report as well. We believe this is the only way to understand what to fear and what the limits are.

25 Jin Chen, Ximing Yin, Xiaolan Fu, Bruce McKern, "Beyond catch-up: Could China become the global innovation powerhouse? China's innovation progress and challenges from a holistic innovation perspective", Industrial and Corporate Change, Volume 30, Issue 4, August 2021, Pages 1037-1064,
https://doi.org/10.1093/icc/dtab032 (accessed April 21, 2022). This article is a summary written by experts to lend authority to the CPC's policies and can be considered more like propaganda for China's own policies.

26 Xiaolan Fu, Bruce McKern, Jin Chen, and Ximing Yin, Chapter 8.1 "Conclusion Innovation in China:. Past, Present, and Future Prospects," The Oxford Handbook of China Innovation, p. 751

27 Zak Dychtwald, "Where Are the Sources of China's Innovation?", Diamond Harvard Business Review, August 2021, p. 114.

1.2 Definition of basic research

As a starting point, we would like to introduce the definitions of basic research in Japan, the U.S., Europe, and China and identify the major differences between these regions as a basis for the analysis that follows. Furthermore, in spite of their length, we would like to give a historical overview of the contents of the Science and Technology Basic Plans to see how the promotion of basic research has been defined and what kind of content has been established in Japan.

1.2.1 What is the definition of basic research?

Regarding basic research in China, the "Interpretation of Statistical Indicators" published by the National Bureau of Statistics of China defines basic research as "experimental or theoretical research conducted to gain new knowledge about the basic principles of phenomena or observable facts, not for professional or specific use or application. Its results are mainly published in the form of scientific papers or scientific works. It is used to reflect the inherent innovative capacity of knowledge[28]." According to the National Natural Science Foundation of China (NSFC), "basic research refers to creative scientific research activities that contribute to new scientific discoveries and the creation of new scientific knowledge that enriches scientific principles. The scientific discoveries and results of basic research are the source of all scientific and technological theory and knowledge[29]."

On the other hand, below are the definitions given by the National Science Foundation (NSF) and the OECD Frascati Manual, respectively.

(U.S. NSF)

"Basic research is defined as systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind[30]."

(OECD Frascati Manual)

"Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view[31]."

1.2.2 What is the perception of basic research in the United States and France?

It is important to emphasize the condition at the end of the above NSF and Frascati Manual definitions, which states

28 "基础研究 指为了获得关于现象和可观察事实的基本原理的新知识 (揭示客观事物的本质、运动规律，获得新发现、新学说) 而进行的实验性或理论性研究，它不以任何专门或特定的应用或使用为目的。其成果以科学论文和科学著作为主要形式。 用来反映知识的原始创新能力。"
http://www.stats.gov.cn/tjsj/ndsj/2017/html/zb20.htm (accessed July 5, 2020) (the above English translation is based on a Japanese DeepL translation of the Chinese text)

29 Tao Cheng, Zhang Zhiquiang, Chen Yunwei, 关于我国建设基础科学研究强国的若干思考 (Few opinions on Building the Basic Research Power of China), paper submitted to the Development and Planning Bureau, Chinese Academy of Sciences, February 2019, http://www.cas.cn/zjs/201904/P020190428642518685962.pdf (accessed May 31, 2021).

30 "基础研究是旨在创造新的科学发现，增加新的原理性科学知识的创造性科学研究活动，基础研究的科学发现成果是所有科学技术的理论和知识源头",
https://www.radford.edu/content/dam/departments/administrative/sponsored-programs/PDFs/NSFdefinitions.pdf (accessed May 30, 2021)

31 https://www.research-operations.admin.cam.ac.uk/policies/frascati-definition-research (accessed May 31, 2021)

that basic research should be conducted with no specific application, product, or use in mind. Let us look at the examples of two countries, the U.S. and France.

The founding purpose of the NSF is to "promote scientific progress and advance the national health, prosperity, and welfare." To that end, it is vital for the NSF to support basic research and the creation of knowledge that will change the future. This support acts as a major force in the U.S. economy, improves national security, and advances knowledge that sustains global leadership. Additionally, the NSF implies the existence of results that can be envisioned beyond pure basic research by using the phrase "supporting high risk, high payoff ideas[32]." While this is a subtle way of writing, it does not seem to call for activities that directly lead to the solution of socioeconomic problems or the creation of innovation, much less follow the linear logic of promoting applied basic research.

The NSF spends about 25% of its budget on basic research in the U.S., and the U.S. is planning to increase this budget in the future. The U.S. recognizes that it is lagging behind in the global competition for innovation, and it is sticking to its policy of strengthening support for linking basic research to innovation and the development of emerging technologies through organizational expansion of the NSF. Although some have expressed concern that the NSF may neglect the promotion of basic research or conflict with the activities of other ministries such as the Department of Energy (DOE)[33], we believe that the government's view of the NSF as a strong promoter of basic research is unwavering.

Now, let us look at the perception of basic research in France. Every five years, by law, France sets out a basic strategy for research, development, and innovation for the entire country (National Research Strategy or Stratégie nationale de recherche [SNR]). The current SNR, issued in January 2017, addresses higher education and research. It aims to "respond to the scientific, technological, environmental, and social challenges France faces in formulating the scientific and technological priorities necessary for the country's sustainable development over the coming decades." The strategy also outlines the priority areas to be promoted by the country. Given that conducting unplanned research has led to significant discoveries, the SNR is concerned about the state strategizing research itself and expresses the value of emphasizing free research. The SNR recognizes basic research as "an important foundation for promoting advanced science and technology" and expresses particular support for "unplanned research" (recherche non-programmée). At the same time, the SNR reiterates that basic research or freedom of research should never be opposed and that the creation of knowledge should always be the top priority. In other words, basic research is defined as exploratory, long-term in duration, risky, unplanned, and having no direct applied purpose[34] The SNR also states that the government does not intend to hierarchize scientific work based on its applied aspects, lest the formulation of such a strategy itself be seen as an attempt to concentrate investment in applied research, which would have a stifling effect on research[35].

32 NSF, What we do, https://www.nsf.gov/about/what.jsp (accessed July 21, 2021)

33 Ariana Remmel, "How a historic funding boom might transform the US National Science Foundation," Nature, NEWS, 23 April 2021, https://www.nature.com/ articles/d41586-021-01076-x (accessed 27 July 2021)

34 LIVRE BLANC DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE 2017, p. 14 and p. 50, https://www.vie-publique.fr/sites/default/files/rapport/pdf/ 174000083.pdf (accessed July 27, 2021)

35 *Ibid.,* p. 51. "La vision de ce Livre Blanc est de ne pas hiérarchiser la valeur des travaux scientifiques en fonction de leur aspect applicatif. Certains voudraient limiter le financement public aux travaux dont les retombées sont prévisibles, et c'est une tendance que nous voyons parfois à l'œuvre dans certains pays.Cela serait rapidement une asphyxie pour la recherche."

1.2.3 How does this differ from the Chinese definition of basic research?

While the NSFC does not promote all basic research in China, it is important to note that the NSFC's definition of basic research does not include the condition that basic research should be conducted with no application, product, or use in mind. This definition of the term "basic research" is used in various policy documents, and funding is provided for research that fits this definition, with significant consequences on what kind of research is actually promoted as basic research. Incidentally, although we are citing the Frascati Manual, we cannot confirm whether China compiles and publishes all statistical figures on scientific and technological innovation according to this manual[36]. This is important, for example, in comparisons of the amount of investment in basic research between major countries, which will be presented in section 3.1.

How do Chinese researchers view these definitions? Since no official documents are available other than the NSFC definition above, we will refer to the paper "Considerations on China's Basic Research Development" by CAS member Fang Xin (received June 15, 2019, revised September 11, 2019).

In this paper, Fang Xin presents her thoughts on the definition of basic research. She, first, presents UNESCO's definition of scientific research, which is divided into three categories: basic research, applied research, and experimental development. Basic research, as defined by UNESCO, is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts. Fang cites the condition "not intended for any short-term professional or specific application or use" and confirms that the condition "without any particular application or use in view" is understood as the common international definition. However, Fang notes that while this definition is efficient for science management and valid as an international comparison, it has its limitations. This is because basic research by this definition tends to be understood as "pure basic research," and if only pure basic research were considered basic research, it would be difficult to obtain government interest and support, especially for developing countries. With the development of science, it has become difficult to "distinguish between some types of pure basic research and applied basic research," and "more and more basic research is linked to national interests and national goals" and "is increasingly emphasized as strategic basic research." Moreover, even in funding agencies in Europe and the United States (NSF in the United States, UK Research Innovation [UKRI] in the United Kingdom, and Deutsche Forschungsgemeinschaft [DFG] in Germany), basic research responds to national and social needs. In Japan, in particular, "the viewpoint that essentially separates basic research from applied research has not been well accepted due to historical and cultural backgrounds." Based on this background analysis, Fang Xin states: "At the Second National Basic Research Activities Conference in 2000, the Chinese government further clarified that basic research is divided into exploratory basic research and strategic basic research, with the former primarily based on the free exploration of scientists and the latter on research that is developed from the needs of major national strategies. Support is now provided for each type of research, and the direction of science and technology policy has become clearer." Fang takes the view that applied basic research, which has been emphasized and promoted in policy documents, can be accurately positioned in terms of policy owing to its significance in science

36 We can only confirm that since 2009, the "number of researchers" has been compiled according to the Frascati Manual (OECD Factbook 2015-2016, Economic, Environmental and Social Statistics, https://www. oecd-ilibrary.org/docserver/factbook-2015-65-en.pdf?expires=1625373535&id=id&accname=guest&checksum=EAF3204DCA53B72E 721F87A509A538B6 accessed July 4, 2021). Therefore, there is a discontinuity in the statistics on the number of researchers between 2008 and 2009.

management and its internationally common framework.

We are not certain to what extent Fang Xin's statements are representative of Chinese views. However, we believe that the above discourse at least gives academic significance to the applied basic research that the Chinese government has emphasized and promoted in successive policy documents, providing an academic rationale for state involvement in basic research. We believe that this has led to a natural acceptance of "basic research that also pursues applications or meets the needs of the nation and society" by the government, bureaucracy, and research institutions alike.

It is unclear whether research based on the curiosity and free ideas of scientists is actually being neglected in China. However, one of the important perspectives of this report is that the focus on applied basic research in the national promotion policy and the concentration of financial and human resources on this type of research puts considerable pressure on researchers in the field to always keep in mind the needs of the nation and society when conducting basic research. Meanwhile, this policy sacrifices the attitude of valuing "serendipity" based on the free ideas of researchers and may be the cause of the abovementioned "lack of originality." To reiterate, it is clear that there is such a thing as applied basic research. The problem is that by making it the pillar of basic research promotion for the entire country, China is overlooking the importance of pure basic research and the fact that its broad scope will eventually generate the power of innovation. Incidentally, the promotion of large-scale R&D in areas such as quantum physics, artificial intelligence (AI), and synthetic biology as so-called mission-oriented projects requires broad and deep basic research to be used as a reference, and the existence of such research will determine the success or failure of mission-oriented projects.

Next, let us consider whether China's promotion of applied basic research is modeled on Japan.

1.2.4 How has basic research been positioned and promoted in Japan?

As noted by Fang Xin above, in Japan, "the viewpoint that essentially separates basic research from applied research has not been well accepted due to historical and cultural backgrounds." How, then, has China, which has thoroughly studied Japanese science and technology institutions and policies, developed such a view? To understand this point, it is necessary to analyze the actual, institutional, and legal policies regarding the promotion of basic research in Japan.

First, we will give a historical overview of the promotion of basic research at the Science and Technology Agency, which had a central role in science and technology administration.

Pure basic research, or basic science, as an academic and scholarly discipline, has traditionally been conducted at universities under the former Ministry of Education, under the name of "academic research." However, "basic research," in particular, has not been protected as a special activity to be conducted by universities. Prior to its merger with the Ministry of Education, the Science and Technology Agency was the institution tasked with implementing administrative measures while establishing a policy position on basic research.

The Science and Technology Agency was established in 1956 as an external bureau of the then Prime Minister's Office and maintained a central role in Japan's science and technology administration until 2001, when it was merged with the then Ministry of Education. Without going into the details, it can be said that at that time, the government was still in charge of all aspects of nuclear power administration, from R&D to power generation, and, therefore, less emphasis was placed on non-nuclear power administration. In other words, considering the weight of nuclear power administration, it can be said that the significance of the agency's existence and its place as an administrative or science and technology institution were not firmly established.

At that time, it was very difficult for the Science and Technology Agency, an external bureau of the Prime Minister's Office, to provide financial support to university researchers by setting up a research system with a budget of its own, and to obtain the cooperation of the university researchers themselves, making the project itself very challenging. To advocate for the promotion of basic research, the agency had to distinguish it in some way from academic research. To that end, the authority that the Science and Technology Agency could exercise at that time was, for example, one of general coordination among ministries and agencies, which was the arena of a coordinating agency as an external bureau of the Prime Minister's Office. Without entering into the details, at that time, the Science and Technology Agency's financial measures as a coordinating agency were projects assembled from the standpoint of coordinating the R&D of various ministries and agencies using Special Coordination Funds for Promoting Science and Technology, and the aspect of basic research was included in these projects. Then, shielded by the powerless administrative weapon of general coordination, the activities of the special corporations and experimental research institutes under the agency's jurisdiction were enhanced to the maximum extent possible to promote R&D. The secretariat of the Council for Science and Technology Policy was responsible for securing its existence as an institution, seemingly in parallel with general coordination. In other words, as the secretariat of the Council, the Science and Technology Agency formulated the basic policy for science and technology administration for the entire nation, while positioning its activities in the space between the activities of other ministries, including the Ministry of Education and universities, and the Ministry of International Trade and Industry.

The policy that was emphasized in the successive Basic Reports and Guidelines for Science and Technology Policy formulated in this way was the "promotion of basic science and R&D in priority areas[37]." The system was designed to have activities designated as "priority areas" or "priority R&D areas" carried out by special corporations such as RIKEN, the Research Development Corporation of Japan (now the Japan Science and Technology Agency), and R&D institutes. The policy of priority areas created an institutional foundation for establishing important niches for science and technology administration, and this was the actual stage where the functional position of science and technology administration, "from basics to implementation," was clarified.

The system that was devised through this process is known as the Exploratory Research for Advanced Technology (ERATO) system. The development of the system leading up to this point is detailed in "History of Science and Technology Agency Policies: Their Establishment and Development," edited by the Watanabe Memorial Foundation for the Advancement of New Technology[38]. According to this article, around 1980, the Science and Technology Agency recognized that basic research was "the area that should be given renewed emphasis as part of the national science and technology policy." Although "spontaneous basic research" was conducted by universities, it was considered necessary to "orient basic research to meet administrative needs and purposes" and to establish "a system to generate ideas in a planned and effective manner," as frameworks for this part of basic research were considered "insufficient and in need of being created." In essence, ERATO was an institution that found a pathway to enable the Science and Technology Agency to conduct basic research, which had always been questioned in terms of the agency's

37 For more information on the evolution of the Science and Technology Basic Plan, see the following paper. Kobayashi Shin'ichi, Akaike Shin'ichi, Takayuki Hayashi, Tomizawa Hiroyuki, Shirabe Masashi, Miyabayashi Masayasu, "Transition of Science and Technology Basic Plan and Future Prospect," J-stage, The Journal of Science Policy and Research Management, vol. 34 (2019), no. 3, https://www.jstage.jst.go.jp/article/jsrpim/34/3/34_ 190/_pdf (accessed July 25, 2021)

38 "History of Science and Technology Agency Policies: Their Establishment and Development," July 27, 2009, Watanabe Memorial Foundation for the Advancement of New Technology

relationship with universities, as a matter of policy, using what was then the Research Development Corporation of Japan. The key purpose was "identifying and cultivating ideas leading to innovative technologies in a broad and efficient manner[39]," that is, "expressing ideas as early-stage technologies and conducting basic research to achieve them[40]." In other words, although this was basic research, the objective or outcome of the activity was directly linked to socioeconomic needs, and for a certain period of time, teams of prominent researchers, including university researchers, were formed to conduct efficient research activities. Subsequently, various institutions were established based on the ERATO philosophy, and from the mid-1980s, needs-based research institutions, which were considered "typical of the Science and Technology Agency," were created under the name of "strategic basic research" or "goal-oriented large-scale basic research" to conduct "basic research appropriate for national implementation" with "clearly stated goals," "while taking advantage of researchers' ideas."

This series of events is the very process by which the Science and Technology Agency of the time sought out certain administrative niches and is quite different from the Chinese method of promotion through application-oriented guidance that influences the way basic research is conducted overall. This is related to the purpose of this report and will be discussed again in section 6.1.1.

Incidentally, when it comes to promoting basic research with a managerial approach, the general theory is that such an approach should be "needs-oriented" or "show the leading edge to be pioneered through rational and scientific thinking." Usually, the latter is not considered to be done directly by the administration in the West, or even if it is, it is rare, and it may become the object of scientific disputes during the peer review process for grants. However, by embedding the subtle function of charting the course of science in its administration, China may be implementing a similar process to the one devised in Japan for strategic basic research and the like.

Next, let us look at the position of basic research in the Science and Technology Basic Plans, which have been in place since the time of the Council for Science and Technology Policy. A Science and Technology Basic Plan is formulated every five years in accordance with Article 12 of the Basic Act on Science and Technology[41] enacted in 1995. The Sixth Basic Plan was formulated in March 2021. This section traces references to "basic research" from the first Science and Technology Basic Plan formulated in 1996 and examines the changes in emphasis related to this policy.

Regarding basic research, the First Plan states that "the role of national R&D institutions, etc., is important" and "basic research will be actively promoted." The plan further states that "the government will conduct R&D that the private sector cannot adequately undertake, such as basic research" and, in doing so, will consider "harmonious development of research from basic to applied" and "respect for researchers' autonomy." In terms of funding, the "Expenditure for Promotion of New Basic Research Utilizing Special Corporations, etc." introduced in FY1995 formed part of the so-called "expansion of competitive funds."

The Second Plan, formulated in 2001 at the beginning of the new century, set out a policy for Japan, which was still

39 *Ibid.,* p. 27

40 *Ibid.,* p. 29

41 In the 201st session of the Diet in 2020, in light of the fact that science, technology, and innovation had become inextricably linked to the state of human beings and society owing to the rapid progress in these areas in recent years, the Act Partially Amending Basic Act on Science and Technology and Related Acts (enforced in April 2021) was enacted to add "science and technology whose sole concern is the humanities" and "innovation" as targets of promotion; further, it introduced items such as consideration of the characteristics of each field and addressing social issues using knowledge from all fields as policies to promote science, technology and innovation. The Basic Act on Science and Technology was also renamed Basic Act on Science, Technology and Innovation. (Excerpts from the Cabinet Office website)

lagging behind Europe and the United States, to catch up with and surpass these regions. The plan calls for further improvement of the quality of basic research to generate knowledge and for the creation of a research environment to enhance the creativity of young researchers in particular. The plan also states the necessity of establishing a dynamic circulation system in which the results of basic research are returned to society and industrial activities and lead to investment. The plan further states that "basic research, which aims to discover new laws and principles, create original theories, and predict and uncover natural phenomena based on the free ideas of researchers, contributes to the expansion of the intellectual assets of humanity, and at the same time, leads to breakthroughs such as world-class research results and innovative technologies that support the economy." The well-known goal of "producing 30 Nobel laureates in 50 years" was set in the Second Plan.

The agenda of the Third Plan, formulated in 2006, was to encourage "strategically focused science and technology" by "promoting basic research," which was becoming increasingly important, and "focusing R&D on national and social issues." This would be achieved through government R&D investment, which had been expanded amid the tight fiscal situation in the long period of stagnation that followed the collapse of Japan's bubble economy. The plan also noted that Japan's position in the world had improved in terms of the "quality and quantity of research papers" but that to be comparable to Western countries, Japan still had to "accumulate a sufficient depth of knowledge that will become a source of discontinuous technological innovation." Basic research was described as a "source of knowledge" but also as "the most uncertain" form of research that "does not always produce results as initially intended" and "is realized through the accumulation of trial and error and the diligent and sincere search for truth." The plan also noted the importance of "fostering an attitude of innovation, as it is discoveries and inventions outside the framework of existing knowledge that lead to breakthroughs in knowledge." Another important perspective introduced in this plan was that "basic research includes research based on researchers' free ideas and basic research for future applications based on policies, both of which should be promoted based on their significance." The former promotes the search for universal knowledge from a long-term perspective, starting from the earliest stages, while the latter is positioned as "policy-directed R&D" and "pursues the creation of knowledge that will be a source of discontinuous innovation leading to economic and social transformation to achieve policy goals." The difference from the Chinese policy documents introduced in Chapter 2 is the link between the Grant-in-Aid for Scientific Research funding program and "research based on free ideas." The plan seeks to "ensure a thorough understanding that the focus on policy-directed R&D does not target basic research as a whole, and that research based on researchers' free ideas, which is funded by Grants-in-Aid for Scientific Research, is promoted independently from policy-directed R&D." The plan also stated that "research based on the free ideas of researchers that requires a large investment of resources will be undertaken after a rigorous evaluation based on the initiative of the researchers, and the government will make decisions, including prioritization among projects, and take action accordingly." Here, there seems to be a subtle distinction between the government-driven policy-directed model and researchers' free ideas.

Now, let us look at the Fourth Plan (2011). Around this time, note was taken of a gradual downward trend in Japan's share of papers, which made it all the more important to drastically enhance basic research. With regard to innovation, open innovation had become the mainstream, and a broad network of "knowledge" and "building a more open system of science, technology, and innovation" were being advocated. Although basic research is said to be conducted "based on the free ideas of researchers," basic research is positioned as a "source of innovation," "creative and diverse basic research" is emphasized, and efforts to "drastically enhance" it are promoted. To achieve this "drastic enhancement," basic research is to be broadly and continuously promoted as a means to "the creation of intellectual assets common to mankind and the accumulation of profound knowledge" based on "initiative and creativity." The government "will support basic research based on the free ideas of researchers, and increase basic expenses for university operation (...) in order to enable academic diversity and consistency, and ensure seedbeds for intellectual activities." Furthermore, the government will "expand Grants-in-Aid for Scientific Research in order to ensure a 30% new adoption rate and 30% indirect costs." The plan also states that "to develop seeds produced from the aforementioned research to achieve goals, etc., the government will develop and improve various research fund systems."

The basic understanding of the Fifth Plan (2016) is "drastic initiatives for strengthening the foundations" of science and technology, namely the reform and functional enhancement of universities, and the training and career advancement of young researchers who will lead the way "in an era of uncertain prospects." These "foundations" include "the abilities of the researchers at the core of STI," "the academic and basic research needed for creating diverse and exceptional knowledge at the source of innovation," and "funding that supports all STI activities." In particular, the report calls for strengthening "fundamental technologies" and states that "it is important to move forward with R&D not in a linear model, which begins from the basic research stage, advances to the development stage, and then proceeds on to social implementation, but instead in a spiral fashion, in which the development, social implementation, and basic research stages mutually stimulate each other. This will provide an environment in which new science can be created and innovative technology can be produced, and where developing the technology into a practical application and commercialization can be worked on simultaneously in parallel." The term "social implementation" is used for the first time in this plan, indicating the idea of R&D proceeding in a spiral fashion with basic research. The plan also notes that the importance of universities and public research institutions in "knowledge creation" continues to increase but that the number of papers and other data has not grown sufficiently; it expresses concern about the decline in "basic research capabilities." Notably, "academic research" and "basic research" are mentioned side by side in the Fifth Plan. To promote "academic research that produces original, high-quality, and diverse results based on the intrinsic motivation of researchers" and "basic research based on policy strategies and demands," the government will "consider the balance between the two" and "work to reform and enhance" them. Although in the past basic research itself would have been divided into academic research and research based on policy strategies, "academic research," as used by the former Ministry of Education, appears in its full form here, and the plan includes a dedicated section entitled "Reform and enhancements to promote academic research." While the "intrinsic motivation of researchers" is particularly emphasized, "academic research" is confirmed to be a "source of innovation," and the expansion and enhancement of Grants-in-Aid for Scientific Research from this perspective is strongly advocated. In terms of the reforms and enhancements to "promote strategic and on-demand basic research," which are the main focus of the plan, it is first stated that basic research needs to be reformed to "formulate strategic goals based on objective evidence," which implies giving strategic goals themselves a scientific outlook. This requirement is similar to the approach seen in the Chinese policy documents introduced in Chapter 2. Regarding the path leading to innovation, the view of "progress proceeding not in a linear model, but instead in a spiral of mutual interactions," introduced in the Fourth Plan, is repeatedly emphasized. A distinctive feature of the Fifth Plan is that academic research is separated from and juxtaposed with basic research[42], and what was previously defined as "research based on the free ideas of researchers" is absorbed into "academic research." This is presumably because "academic research" has been positioned as a clear target under the jurisdiction of the Council for Science, Technology and Innovation. From another angle, this is also an acknowledgment that the former Ministry of Education's area of responsibility clearly falls within the purview of the Council for Science, Technology and Innovation.

The basic understanding of the Sixth Plan, formulated in 2021, is that the international situation, as represented by the U.S.-China conflict, has given rise to increasing competition in "cutting-edge basic research and the practical application of the results." The report further states that basic research and academic research are becoming increasingly important "not only for discovering and identifying new phenomena but also for creating 'knowledge' that will lead to the creation of original new technologies." The juxtaposition of academic research and basic research continues here, always in the form of "academic research and basic research" as a set. The plan also reaffirms that "discontinuous changes" create innovation, reiterates the need to further strengthen "basic research capabilities," and emphasizes that "there have been cases in which basic research and academic research have been directly linked to social implementation." Incidentally, "basic research" is described as "exploring the truth, clarifying basic principles, and discovering new ones," and "academic research" is said to be conducted "based on the intrinsic motivation of individual researchers." Both forms of research are considered "sources of value creation," as mentioned above, and "fundamental functions of the nation." As an extension of this, the direction of creating "knowledge as a source of value creation by designing a new society" is indicated, and the utilization of "convergence of knowledge" is called for. This "knowledge" itself is positioned as "a source of innovation creation that will respond to discontinuous changes and solve social problems" and is said to be accumulated through academic research and basic research. Through the Moonshot Research and Development Program created in 2018, "the government will also actively promote challenging R&D to draw out basic research capabilities to the maximum extent and will seek to discover and develop innovative research results while allowing for failure." The promotion policy is also written in an integrated manner under the heading "Promotion of basic and academic research." For academic research, the emphasis is mainly on measures to "secure and enhance financial resources that can be used at the discretion of the organization" and to "secure and enhance Grants-in-Aid for Scientific Research that support (...) young researchers, further promotion of emerging and fusion research." This is followed by a description of "Strategic Basic Research Programs." The plan also stipulates the promotion of "priority support for young researchers and seamless support for excellent researchers" and of "basic research with a view to the post-corona era." With regard to "strengthening basic research capabilities," in particular, "seamless support" is again emphasized, and Grants-in-Aid for Scientific Research and Strategic Basic Research Programs are mentioned as avenues to ensure that young and mid-ranking researchers "can secure research funding in a stable and sufficient manner." In terms of "projects that link the results of basic research to industry," it is said that "the government will strengthen systems for evaluating academic values and flexible support systems in accordance with research phases, including support for matching with industry," which suggests systems to bridge the gap between academic research and industry. The plan states that national R&D agencies will conduct "basic

42 The term "separated" implies that academic research was included in conventional basic research. However, this is actually a complex issue, as it may be pointed out that since the time of the former Ministry of Education, academic research was under the purview of the Science Council, an advisory body to the Minister of Education, and was not subject to the administrative measures of the former Science and Technology Agency, which was set up by the then the Council for Science and Technology.

and fundamental research that is difficult for the private sector" under a "long-term vision" based on "national (...) demands." In any case, the government will "secure sufficient investment in basic research" and "strengthen responses to important national issues." In the Sixth Plan, "academic research" is positioned with a clearer sense of presence, and "basic research" is relatively clarified as contributing to solving social and economic issues based on national demands. Even if basic research is dictated by national demands, wariness from the scientific community is no longer a particular concern, and the government's position is now more clearly to strategically promote basic research. However, there is no sense here of a national will that demands planning and efficiency and institutionally and systematically ensures it to the extent that China does. This point will be discussed further in section 6.1.1.

The above is an overview of the policy definition, positioning, and promotion measures of basic research and its promotion in the Science, Technology, and Innovation Basic Plan (until the Fifth plan, the "Science and Technology Basic Plan"). What is the position of basic research and its promotion under the law? Japan's Basic Act on Science, Technology and Innovation defines "research and development" as "basic research, applied research, and developmental research, and including the development of technologies." Regarding "policymaking considerations for the national and local governments," Article 8 of the act states that "When formulating and implementing policies for the promotion of science, technology, and innovation, the national and local governments must keep in mind the importance of the roles that they play in the progress of basic research, remaining mindful that basic research brings about the discovery of new phenomena, breakthroughs in understanding them, and new and creative technological innovations; however, it is also difficult to predict what results basic research will yield from its inception, and its results do not always have a practical application." The act emphasizes that basic research typically has results that are "difficult to predict" and "do not always have a practical application." In January 2020, in amending the Basic Act on Science and Technology, the Science Council of Japan showed a certain wariness of so-called application-oriented basic research, expressing its hope that "the revised act will serve as a guideline for the formulation of future Science and Technology Basic Plans, clearly indicating the direction that will lead to the long-term and sustainable development of Japan's research capabilities, especially basic research that is not necessarily directed at specific and concrete applications and uses[43]."

The establishment of ERATO and its significance in the administration of science and technology has already been discussed. However, looking at the history of ERATO and the positioning of basic research in the Science and Technology Basic Plan, in a sense, the policy positioning of ERATO can be seen as a power struggle between ministries and agencies centered on the administration of science and technology. In other words, "academic research," which was clearly addressed in the Sixth Plan, actually existed even before the Fifth Plan. However, after struggling to distinguish basic research from academic research, the committee redefined basic research as "strategic research to solve social and economic problems in response to national demands." The distinction is that while basic research values researchers' ideas, it does not pursue knowledge for the sake of knowledge as much as academic research. In this way, the Science and Technology Agency, or the science and technology-related bureaus of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) after the integration of the two ministries, emphasized long-term research, from basic science to social implementation, and the spiral development of research rather than a

43 "Statement of the Science Council of Japan Executive Committee on the Amendment of the Basic Act on Science and Technology," Science Council of Japan Executive Committee, January 28, 2020, http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-24-kanji-4.pdf (accessed July 22, 2021)

linear model, to establish a full-fledged institutional foundation in science and technology policy. The Basic Plan for Science, Technology, and Innovation was arguably a policy document that focused its efforts on establishing these agencies as pillars of the programs of the pre-merger Research Development Corporation of Japan and the post-merger JST.

Incidentally, the program of Grants-in-Aid for Scientific Research (commonly known as "KAKENHI") run by the Japan Society for the Promotion of Science (JSPS) under MEXT defines KAKENHI as "competitive research funds that aim to significantly develop all kinds of 'academic research' (scientific research based on researcher's creative ideas) from basic to applied, covering all fields, from the humanities and social sciences to natural sciences. Grants are awarded to creative and pioneering projects that have undergone peer review (in KAKENHI, a system where researchers who have worked diligently in academic research and know the leading edge of 'knowledge creation' review and evaluate each other)[44]." The grants do not specifically use the term "basic research," which is replaced by other terms such as "fundamental research." As seen in the latest Science, Technology and Innovation Basic Plan, MEXT's higher education and academic personnel are considered to operate only in the academic research arena and are unlikely to be discussed in the context of the policy positioning of basic research, which is the subject of this report. Therefore, we will not go further into this topic here.

1.2.5 Is JST R&D similar to applied basic research in China?

The act establishing JST provides that one of the duties of the agency is "conducting basic research and fundamental R&D concerning science and technology that will contribute to the creation of advanced technology" (Article 23-1). Even "basic research" is premised on the assumption that it will "contribute to the creation of advanced technology." This promotion of basic research seems very similar to China's promotion of "applied basic research" which is the subject of this report.

In its fourth medium-term goals, JST aims to take advantage of its characteristics "as a network research institute," to "proactively promote original and challenging R&D that leads to innovation, and establish a system that enables consistent implementation from basic research to practical application support and intellectual property creation under a program manager." JST states that in doing so, it will "organically combine the necessary support to create innovation, including support for bridging the gap between industry-academia-government collaboration, venture startup support, and intellectual property creation, according to the stage of R&D progress, and establish a management system to enable the seamless and consistent support necessary to create innovation, keeping in mind that innovation is created discontinuously even at the stage of basic research." The key concepts are "a system that enables consistent implementation from basic research to practical application support," "discontinuous creation of innovation from basic research," and "bridging the gap." Specifically, JST states that "in promoting strategic basic research, we will promote internationally advanced, outcome-oriented basic research to achieve our strategic goals and obtain research results that will lay the foundation for new technologies that will contribute to the creation of scientific and technological innovation. In addition, from the perspective of creating scientific and technological

44 For more information on the purpose and characteristics of the Grant-in-Aid program, see https://www.jsps.go.jp/j-grantsinaid/01_seido/01_shumoku/index.html (accessed January 15, 2022).

innovation and aiming for practical application, we will accelerate and deepen research on promising results through innovation-oriented management, thereby seamlessly promoting the process from basic research to the deployment of research results." This description of "outcome-oriented basic research" and "seamlessly promoting the process from basic research to the deployment of research results" is similar to the stipulations of the Chinese policy documents discussed in Chapter 2.

JST's R&D is positioned in this way, and the term "directed basic research" is used to bridge the gap between "knowledge creation" and "applied and practical research[45]." This case study is a theoretical analysis of "bridging the gap," which is the mission of JST, conducted by typifying the process of "stage gate" setting and "gate management," and it strengthens the theoretical foundation for JST's existence, cementing its image as an institution that promotes directed basic research. Although we will not go into the details of this case study, we believe that it was significant in drawing a line between the general policy for the promotion of basic research and the policy of JST. The most important difference, however, is that in the case of Japan, as mentioned earlier, Grants-in-Aid for Scientific Research are linked to research "based on free ideas," and JST has been established as an independent organization responsible for applied basic research, whereas in the case of China, the general policy to promote basic research only emphasizes applied basic research. As we will discuss again after analyzing the Chinese policy documents, a comparison of policies for the promotion of basic research in the U.S., France, and Japan with those of China shows that the Chinese approach adheres to the model of state involvement, in which people, financial resources, and equipment are invested systematically and efficiently under the leadership of the Communist Party to generate a certain level of innovation. In China, the fundamental process of research based on the free ideas of researchers is not mainstream, and research is always application-oriented, through such means as the "organic combination of free inquiry and targeted guidance," "linking fields of interest with the demands of national strategy," and "using the status of accomplishment of national missions as an important criterion for evaluation." This approach is quite peculiar, and it may be the cause of the lack of originality in Chinese research. To analyze and evaluate the state of basic research in China, we must take a closer look at the impact of this attitude in policy formulation on the field of research. We will examine this point in more detail in the next chapter.

45 Yoshida Hideki, Azuma Ryota, Nakada Kazutaka, Shinohara Joji, Sasa Tadashi, "Case Study on Bridging the Gap from Directed Basic Research to Applied and Practical Research to Create Innovation ("Hot Issue" Management for Innovation - 1)," October 21, 2006, Proceedings of the Annual Conference of the Japan Society for Research Policy and Innovation Management, https://www.jstage.jst.go.jp/pub/pdfpreview/randi/21.1/0_21.1_9.jpg (accessed July 27, 2021)

2 Trends in Basic Research Promotion and Scientific Research Management Reform Policies in China

This section traces the main references to the promotion of basic research and the reform of scientific research management in policy documents by the Communist Party of China, the State Council, and relevant ministries. The individual descriptions introduced below will be carefully examined while considering the policies of the U.S., France, and Japan, and especially the meanings implicit in them, to understand China's intentions and effectiveness in promoting basic research and creating innovation. The post-Chinese economic reform documents discussed in this chapter are highly regarded by Chinese researchers as important for the promotion of basic research and the reform of scientific research management, according to a separate study commissioned to Tepia Corporation Japan[46].

This report focuses, in particular, on the position of basic research and the development of institutions for science and technology management ("scientific research management") in terms of finance, personnel, evaluation, and other aspects related to science and technology.

As far as the authors know, Chinese policy documents are carefully prepared and finalized after years of analysis and synthesis involving the CPC Central Committee, various departments of the State Council, and if necessary, relevant authorities at various levels of local government, and are the result of an ideology that has been gradually constructed over a long period of time. This ideology, which is assembled without a single gap in the meticulously selected words, must not contain even the slightest error. It is built on the logic that if anything is missing, it is either due to the "insufficient thoroughness" of the previous ideology or the need for "deeper implementation." Moreover, these documents are produced with a long-term perspective in the order of several decades or more and even have some universality.

46 The commissioned study cited multiple times in this report is the Tepia Corporation Japan's "Study on the mechanism of discovery and promotion of the excellence in China's R&D system" (2021). The final report of this study is published on JST Science Portal China.

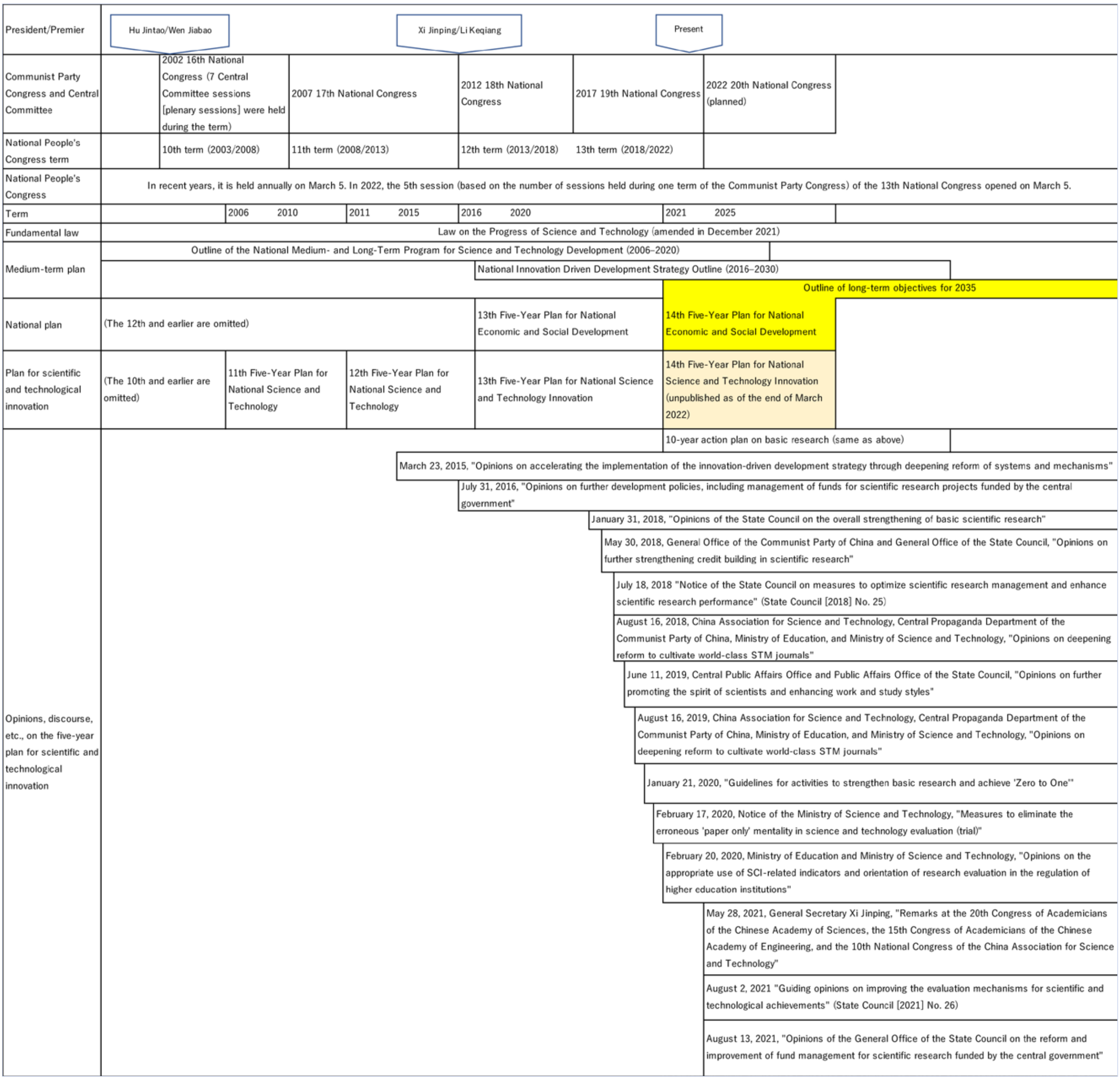


Figure 1: Overall diagram of the Congress of the Chinese Communist Party, Central Committee of the Communist Party of China (CPC) (plenary session), National People's Congress, plan for economic and social development, plan for scientific and technological innovation, and party leadership opinions[47]

(prepared by the authors based on various sources)

As noted by Professor Zhang Xiaojin of Tsinghua University's School of Social Sciences, such thinking is based on the precept that "unless long-term national policies are enacted, national security will be temporary[48]." Scientific and

[47] The guidance and opinions listed here are referred to individually in this chapter, and Japanese translations of them are available in the Basic Documents section of the JST Science Portal China. https://spc.jst.go.jp/policy/

[48] Zhang Xiaojing (Professor, School of Social Sciences and Dean, School of Political Science, Tsinghua University), [[21-25] China's National Planning and Policy Formulation Process: Key Points of the 14th Five-Year Plan and 2035 Long-Term Goals (Part 1)], Sino-Japanese Economic Relations in the After Corona Era, Science Portal China, June 17, 2021, https://spc.jst.go.jp/experiences/special/economics/economics_2125.html (viewed July 27, 2021)

technological innovation policy is also positioned within this larger concept. The policies that have been successively adopted since the founding of the country have all been consistently based on the positioning of "scientific and technological innovation that contributes to the social economy." Policies related to the promotion of basic research are arguably among the foundations of such a stance. According to Professor Zhang, "setting long-term goals, enacting specific policies, and documenting and explaining the detailed implementation process in chronological order have been the most effective means of gaining public support and the driving force behind the economic and social development of the nation. Successive generations of Chinese leaders have followed this traditional policy of governing the country[49]." Therefore, it would be worthwhile to closely examine the policy documents related to the promotion of basic research and to illustrate China's intentions and their effectiveness in creating innovation.

Before going into the relevant policy documents, it is important to understand the structure of China's policy documents in general. This will be explained in broad strokes below. Figure 1 gives an overview of the basic organizations that issue various policy documents and the decision-making opportunities from the Communist Party Congress to the National People's Congress.

2.1 Pre-Cultural Revolution policies

When discussing a specific topic related to China's science and technology policy such as that of this report, one needs to decide how far back in time to go. Usually, it is appropriate to start from the period when the Cultural Revolution of the 1960s, which changed China's politics, economy, society, and culture, was almost at its conclusion.

First, however, we would like to highlight the points emphasized in the Outline of the Long-term Plan for the Development of Science and Technology (1956-1967)[50]. This was based on the Twelve-year Plan for Scientific and Technological Development concept that emerged after the policy for the development of the atomic bomb was decided, and it was the first medium- to long-term plan for science and technology since China was founded. Needless to say, in the global situation immediately after World War II, China was forced to devote much of its national power, including the power of its scientists, to the development of the atomic and hydrogen bombs in parallel with its founding efforts to catch up to the major Western countries in the competition for the development of these weapons. As a result, it appears that the government did not indicate so-called "promotion of basic research" or "freedom of scientific research" as a policy direction at this time. In any case, this outline stalled after two years owing to political turmoil, leading to the formulation of the Plan for Scientific and Technological Development (1963-72), which also set the overall goal of "catching up with the level of science and technology of advanced countries in the 1960s[51]." Therefore, from the postwar period to this time, China did not have the luxury of advocating "promotion of basic research" and "freedom of scientific research" as policy values.

While the abovementioned outline focused on reaching the major goal of the founding period, that is, building a military and industrial base, the "Fourteen Opinions on the Current Work of Natural Science Research Institutions," submitted by the National Science and Technology Commission and CAS in 1961, and approved by the CPC Central

49 *Ibid.*

50 Yutaka Kawamura, "On the History of Science and Technology Policy in China, Part 1" (typographical error corrected February 23, 2013)

51 *Ibid.*

Committee in July of the same year, are also referred to as the "first general and systematic science and technology policy document[52]." It is said that these opinions "aimed to make correct political decisions for China's intellectual class, to guarantee them working conditions for scientific research and some freedom of choice of topic, as well as guaranteeing the Party's leadership and responsibility in scientific research institutions[53]." Although it is impossible to know the specifics behind the term "some freedom of choice of topic," the fact that the term "freedom" was chosen and used in an official government opinion is noteworthy. This was also the time when Mao Zedong acknowledged the failure of his Great Leap Forward policy and indicated that he was open to criticism within the party[54]. It was at this time that the term "freedom" was first presented to the people for a brief moment before the Cultural Revolution.

2.2 Basic institutions and framework for science and technology after the Cultural Revolution

Subsequently, the country would continue to follow the Chinese economic reform from 1978 onward, and the National Science Congress held in March of that year marked a time of rapid progress. The Congress is said to have ushered in a "spring of science" for China, with many reforms made in human resources, financial investment, and institutional management[55]. The 1982 proposal, however, emphasized science and technology policy only in the context of economic development, aiming to promote the combination of science and technology with the economy and to increase productivity through science and technology.

(1) Decision on the Reform of Science and Technology Systems (1985)

The Decision on the Reform of Science and Technology Systems issued by the CPC Central Committee in 1985 marked the full-scale start of the reform of science and technology systems. The Decision on Issues Related to Deepening Science and Technology Systems issued by the State Council in 1987 used the term "liberalization of scientific research institutions" and advocated the "relaxation of management policies for scientific researchers." We do not know the details of what freedoms were actually granted to the institutions with the term "liberalization." However, in 1992, the National Science and Technology Commission and the National Economic Reform Commission issued the Opinions on Human Resource Transfer, Structural Adjustment, and Deepening Science and Technology System Reforms, which proposed "stabilizing one part to liberalize another" in order to "adjust science and technology policy in relation to the market economy." "Stabilizing one part" refers to "stabilizing basic research activities and the science and technology talent pool," and "liberalizing another" means "encouraging the independent involvement of science and technology activities in social and economic construction[56]." In this vein, it can be said that "free research" only exists within the context of "contribution" to social and economic construction.

52 "Policy Transition and Development History of Science and Technology in China" (March 2019, JST China Research and Sakura Science Center), p. 1

53 *Ibid.*

54 Masuo Chisako, "Principles of Chinese Behavior," Chuokoron Shinsho, November 2019, p. 122. According to Masuo, "in January 1962, at a Seven-Thousand Cadres Conference (central expansion work conference) meeting held to revise the line, Mao Zedong admitted the failure of the Great Leap Forward policy and humbly showed the party leadership that he welcomed their criticism of him."

55 JST China Research and Sakura Science Center, *Ibid,* p. 2

56 *op. cit.,* p. 2.

(2) Establishment of the National Natural Science Foundation of China (1985)

The National Natural Science Foundation of China (NSFC) was established in 1985. This foundation is the Chinese version of the NSF in the U.S. Its mission is to formulate and implement a grant plan for basic research and human resource development, and it can be considered the core organization involved in the promotion of basic research, which is the subject of this report. It is said that "The NSFC's basic research support program is a major project to support early-stage basic research that emerges from the bottom-up ideas of researchers[57]." The NSFC's specific measures to promote basic research, especially the funding mechanism, will be introduced and further discussed in Chapter 5.

(3) Progress of Science and Technology Law (enacted in 1993, amended in 2007 and 2022)

① Contents of the 2007 amended law

This law was originally enacted in 1993; it was first amended at the 31st session of the Standing Committee of the 10th National People's Congress on December 29, 2007. Although it is difficult to make a detailed comparison of the law before and after the amendment, the old law, which was "mostly about directions and policies to promote science and technology," was replaced with "detailed provisions for expanding investment in high-tech industries, corporate R&D, technology introduction, and the accompanying tax incentives and treatment of researchers." It is said that the amendment was such a major revision that it could be described as "enacting a new law[58]." Although it is difficult to confirm whether or not certain articles were amended, the following is a description of the distinctive articles from the amended law that are relevant to this report.

Article 1 states that the purpose of this law is "promoting the progress of science and technology (...) in order that science and technology shall render service to economic and social development." Article 3 states that "The State guarantees the freedom of scientific research and technological development, encourages scientific exploration and technological innovation and protects the legitimate rights and interests of scientists and technicians." Note that the term "guarantee the freedom" is used. Meanwhile, Article 4 establishes an "obligation" that "economic and social development shall rely on science and technology, and scientific and technological progress shall serve economic and social development." As a corollary, Article 19 states, "The State shall abide by the principle of combining service rendered by scientific and technological activities to national goals with encouragement of free explorations; make far-sighted arrangements; and develop basic research, research of frontier technologies, and technological research for public welfare and support sustained and stable development of the same. Scientific research and technological development institutions, institutions of higher education, enterprises and other institutions, and citizens shall, in accordance with law, have the right to independently select subjects for basic research, research of frontier technologies, and technological research for public welfare[59]."

The issue here is whether there are specific institutions in operation to achieve the institutional balance between the freedom of scientific research and the demands of the State. Such a balance can be seen as being left to operational regulations further down the line. However, Article 8 of the law stipulates that "The State establishes and improves an

57 *op. cit.,* p. 26.

58 *Ibid*. p. 12.

59 The above quotations of articles of the Progress of Science and Technology Law are based on the translation of the law by the JST China Research and Sakura Science Center, p. 103 onward.

appraisal system for science and technology conducive to independent innovation. The appraisal system for science and technology shall be applied through classified appraisal on the basis of the characteristics of different scientific and technological activities and in adherence to the principles of fairness, impartiality, and openness." Even though autonomy is respected, an appraisal system where researchers control their own destiny should evidently still be "conducive to innovation." One saving grace is that Article 56, which was included in the bill's deliberation process, mentions that "The State shall encourage scientists and technicians to carry out free exploration and dare to assume risks. Where original records prove that, (...) the scientists and technicians undertaking the scientific research and technological development projects, which are highly exploratory and risky, (...) cannot accomplish such R&D, they shall be excused." However, the actual revised opinions specifically note that "the outcome of the project should not be affected," and even the "excuse" is weakened[60], while the requirement of proof by "records" indicates a fully controlled society. We get a sense that in the balance advocated by this law, the element of respecting state demands is dominant. This rupture or loss of balance may be the "resonant defect" in the scientific and technological culture of China, a society that is moving toward the construction of a socialist market economy under the leadership of the Communist Party. We will show how the assessment system is operated when it is examined more specifically in a later section. Incidentally, Article 55 stipulates that "the speed of growth of science and technology expenditures in the national budget shall be higher than the speed of growth of recurrent revenues of the country as a whole" and that "the ratio of science and technology R&D to GDP of society as a whole shall be gradually increased." The latter target for the ratio to GDP is technically difficult to pursue, which is typical of China.

As a side note, although military-civilian integration has been emphasized recently, it should be noted that Article 6 of the law already stipulates that "The State strengthens the connection and coordination of military and civilian scientific and technological plans; further, it promotes the mutual exchange and two-way transfer of military and civilian scientific and technological resources and of demands for technological development, in order to develop the technologies for use by both the military and civilians."

② December 2021 amendment

The law was amended for the second time on December 24, 2021, and entered into force on January 1, 2022, the main amendments being as follows[61]. Article 75, including the supplementary provisions, was expanded to Article 117. The relationship of the law with the promotion of basic research will be further addressed in section 2.5 (1) ③. In addition, the content of the law's provisions does not necessarily correspond to legal matters but often includes party policy and instructional content. Many of the contents are similar to those described in Japan's Science and Technology Basic Plan.

First, with regard to the structure of the law, a method of dividing chapters into smaller sections was adopted, and Chapter 2 "Scientific Research, Technological Development and Application of Science and Technology" of the 2007 Law was divided into Chapter 2 "Basic Research" and Chapter 3 "Applied Research and Commercialization." Chapter 7 "Regional Innovation," Chapter 8 "International Scientific and Technological Cooperation," and Chapter 10

60 JST Pekin Tayori, January 11, 2008 [08-001], "Summary of Amendments to the Progress of Science and Technology Law in China" (accessed May 30, 2021), https://spc.jst.go.jp/experiences/beijing/b080111.html

61 The December 2021 amendments to the Progress of Science and Technology Law are described based on information from JST's Beijing Office.

“Supervision and Management” were added to present new science and technology institutions.

Article 2 states, “The Communist Party of China’s overall leadership over scientific and technological affairs shall be upheld.” It is clearly stated that the innovation logic and strategy of the Party and the State shall be made into law and that S&T self-reliance and self-development shall be the pillars of the national development strategy.

Chapter 2 of this law was the first chapter to be entirely devoted to basic research. This chapter emphasizes the need to strengthen basic research, intensify the creativity and innovativeness of scientific research personnel[62], and reduce the administrative burden on scientific research personnel (Article 19). The lack of investment into basic research is to be resolved, and a support system is to be established, by continuing to support basic research on a long-term and stable basis (Article 20).

Chapter 3 is significant in that it introduces content on “Applied Research and Commercialization”; strengthens the connection between basic research, applied research, and commercialization of results (Article 26); and grants the right of ownership or long-term use of research achievements to scientific research personnel (Article 33).

Chapter 6, “Scientific and Technological Personnel,” in particular, stipulates the reduction of the burdens of science and technology personnel. The amendments strengthen protections for the personnel of scientific research institutes through various measures, such as prohibiting “unfair treatment of scientific and technological personnel and their R&D results in any form” (Article 57) and stipulating that “the state encourages R&D institutions, institutions of higher education, and enterprises to incentivize scientific and technological personnel by means of equity, stock option and dividend schemes” (Article 60). It is further stipulated that the state shall “ensure that scientific and technological personnel have sufficient time to engage in research instead of being overburdened with project application, document submission, and cost reimbursement” (Article 64), and “the state encourages scientific and technological personnel to engage in free exploration and take risks with courage and creates an atmosphere that promotes innovation and tolerates failure.” (Article 68). Since 2010, Premier Li Keqiang repeatedly emphasized the importance of realizing labor values and making researchers passionate about their work, and this issue was addressed in earnest from around 2014. In 2016, the Ministry of Finance, the Ministry of Science and Technology, and the State Financial Commission jointly enacted the “Provisional Methods to Encourage Equity and Profit-Sharing in State-Owned Science and Technology Enterprises.“

With regard to military-civilian integration, Article 6, Paragraph 3 of the 2007 amended law stated that “the State strengthens the connection and coordination of military and civilian scientific and technological plans.” In the current amended law, however, the term “connection” has been deleted, saying that the State “coordinates the development of military and civilian technologies.” On the surface, this change erases the interconnectedness of the military and civilian plans, and although it is a stopgap measure, its details are deserving of attention.

In addition to the above, it is worth noting that the promotion of basic research and social implementation by local governments, science and technology finance, international scientific and technological cooperation, development of a national laboratory system, journal policy, and research integrity are also clearly mentioned. These topics will be introduced as necessary in the relevant sections later in this report, as well as in other relevant research reports.

62 “KAKENHI personnel,” also referred to as “R&D personnel,” is a statistical term consistent with OECD statistics, and refers to those involved in research and development, including so-called research assistants.

2.3 Medium- and long-term plans for scientific and technological innovation

In addition to the legal and institutional framework described above, medium- to long-term plans are prepared every few years. Below is an overview of policies since the end of the 1990s.

(1) National Key Basic Research and Development Program (1997)

One of the most important plans for the promotion of basic research is the 1997 National Key Basic Research and Development Program (commonly referred to as the "973 Program"). The title of this program suggests that it includes the most important content related to the promotion of basic research in general. However, this is in fact "a development program for national priority basic research to meet the strategic needs of the nation" and "to strengthen and support research on many scientific issues that contribute to the social and economic development of the nation[63]." Therefore, the basic research to be promoted is strongly positioned as research to meet national needs. However, an evaluation of the activities over the subsequent decade found that the 973 Program "raised the number of Chinese SCI[64] papers to second place in the world and significantly increased the influence of Chinese researchers in the world[65]."

(2) Outline of the National Medium- and Long-Term Program for Science and Technology Development (2006-2020)

The next medium- to long-term plan we should examine is the Outline of the National Medium- and Long-Term Program for Science and Technology Development (2006-2020). This outline was the general framework for the 11th Five-Year Plan for National Science and Technology and the subsequent plans that were formulated every five years from 2006 and was part of the overall foundation that also included the abovementioned 973 Program. The outline covers "major areas," "major special projects," and "frontier technology and basic research" to be undertaken by 2020. In section "VI. Basic Research," the promotion of basic research is described as follows:

"Basic research constitutes an important source for high-tech development, a cradle for nurturing innovative personnel, a foundation for building an advanced culture [i.e., superstructure, etc.], and an inner driving force for the future S&T development through profound understanding of natural phenomena; unveiling natural laws; and acquiring new knowledge, new principles, and new methodology. The development of basic research shall adhere to the principle of combining meeting the national objectives and encouraging free exploration. In addition, basic research activities shall observe the law of scientific development, respect scientists' exploratory spirit, and pay more attention to the long term value of sciences, with stabilized support, visionary deployment, and dynamic readjustment in line with

63 JST China Research and Sakura Science Center, *op. cit.* p. 26.

64 SCI is an academic database in the field of science and technology created by the Institute for Scientific Information (ISI) of the United States and operated by Thomson Reuters. As a well-known database containing top journals with high global reputation, SCI contains journals with high impact factor, which is one aspect that is used as a standard for evaluating performance in academia worldwide (from https://blog.wordvice.jp/sci-%E8%8B%B1%E8%AA%9E%E8%AB%96%E6%96%87-%E8%8B%B1%E6%96%87%E6%A0%A1%E6%AD%A3-%E9%87%8D%E8%A6%81%E6%80%A7/)

65 *Ibid.*

new trends of scientific development[66].” The interesting part of this stipulation is that basic research “shall adhere to the principle of combining meeting the national objectives and encouraging free exploration.” This expression, when considered carefully, suggests that science and technology should contribute to economic construction and social development but also seems to take the side of researchers by stating that basic research “shall adhere to the principle of combining meeting the national objectives and encouraging free exploration.” It appears that there is not yet the pressure to create innovation by establishing the category of applied basic research, which will be discussed in the latter part of this paper.

(3) Outline of the National Innovation-Driven Development Strategy (2016-2030)

This strategic outline was formulated by the CPC Central Committee and the State Council in May 2016, after the government recognized in 2012 the strategic importance of scientific and technological innovation for the advancement of social productive capacity and comprehensive national strength[67].

Section 1, “Strategic Background,” recognizes that China has entered a breakthrough phase in the development of scientific and technological innovation, moving from an increase in quantity to an improvement in quality through years of effort, but that China’s industry remains at a low level in the global value chain and relies on other countries for core technologies. It is, therefore, necessary to promote scientific and technological innovation, which will drive industrial upgrading and development, particularly to solve the lack of innovation capability of enterprises, to strengthen human resources, and to foster and optimize the market environment and social atmosphere to encourage innovation.

Section 2, “Strategic Requirements,” begins with an outline of “Basic Principles,” which calls for addressing key national issues, clarifying the direction of innovation, building competitive advantages, adhering to scientific and technological institutions and socio-economic reforms, observing the laws of socialist market economy and scientific and technological innovation, being people-centered, emphasizing the initiative and creativity of human resources, and developing teams of innovative human resources. In particular, the last section sets the goals of “properly use global innovation resources to the maximum extent, comprehensively elevate China’s position in the global pattern of innovation, and strive for it to become a leader in a number of important fields and a participant in the formulation of important rules.” “Global innovation resources” are any resources that can be used for innovation in China, including human resources, intellectual property, and facilities or equipment, and the goal is to integrate these resources in various networks. Furthermore, becoming “a leader in a number of important fields and a participant in the formulation of important rules” is seen, in today’s terms, as beginning to work specifically toward securing “institutional discourse power[68].”

The “strategic objectives” are divided into three steps.

66 Outline of the National Medium- and Long-Term Program for Science and Technology Development (2006-2020) http://www.gov.cn/gongbao/content/2006/content_240244.htm (accessed May30, 2021. The Japanese translation was done by Google Translate)

67 The “Outline of the National Innovation-Driven Development Strategy (2016-2030)” is quoted from JST’s “China’s Science and Technology Status and Trends 2019” (https://spc.jst.go.jp/investigation/downloads/r_2019_03.pdf accessed July 16, 2021) (no Japanese translation of the full document is available).

68 According to Professor Kamo Tomoki (Faculty of Policy Management, Keio University), institutional discourse power is “the power to influence other countries through the concepts, logic, values, and ideology contained in one’s own country’s arguments and discourse” and “the power to make others accept what one says.” https://www.cfiec.jp/2021/0056-kamo/ (accessed May 29, 2022)

Step 1 is to “enter the ranks of innovation-oriented countries by 2020 and basically construct a national innovation system with Chinese characteristics.” Specifically, the aim is to achieve a scientific and technological progress rate[69] of at least 60%, value added of 20% of GDP in knowledge-intensive service industries, R&D expenditures of 2.5% of GDP, enhanced vitality of innovation actors, and an optimized innovation environment[70].

Step 2, which sets the objectives for 2030, is to be “ranked among the leading innovation-oriented countries; a fundamental transformation is achieved in the driving force of development, with a major increase in economic and social development level and international competitive strength. Further, the step lays a firm foundation for building an economic superpower and a society of shared affluence.” Specifically, the aim is to achieve high-end participation in key industries, high income and quality of life, an overall transformation of scientific and technological innovation, parallel development with major countries in strategic areas, leading academic development, creation of original results with significant impact, R&D expenditures of 2.8% of GDP, integration and mutual promotion of science, technology and economy, and a situation where “there is a rich culture of innovation, legal system safeguards are strong, and the entire society forms a lively arena in which all of its innovative vitality is released.”

Step 3, which sets the objectives for 2050, is to be “established as a world S&T innovation superpower, becoming one of the world’s main centers of science and occupying the high ground in innovation” and to achieve “the Chinese dream.” Specifically, although this is stated in somewhat abstract terms, the aim is to make science, technology, and human resources important strategic resources; achieve high-quality economic development through overall innovation; reduce energy resource consumption; create a society of industries with strong core competitiveness; produce original scientific results by world-class scientific research institutions, research-oriented universities, and innovation-oriented enterprises; gather world-renowned researchers; create a global hub for innovation and entrepreneurship; and optimize the institutional environment for innovation, respecting knowledge and innovation and protecting property rights.

The above step-by-step objectives are focused on innovation and do not mention the promotion of basic research that supports it at this level. The role of basic research leading to innovation is stipulated at a later stage. After the “strategic objectives” comes Section 3, “Strategic Deployment,” which introduces the guiding concept of “persisting in a two-wheel drive approach, constructing one system, and promoting six major changes.” First of all, the guiding concept of a “two-wheel drive approach” is considered important in the positioning of policies for the promotion of basic research in China. The “two wheels” in this case are “scientific and technological innovation and institutional (...) innovation,” which must be “coordinated” with each other. This section explains that the driving factor in the former are “scientific discoveries,” which play a “guiding role in technological progress,” and that “technological progress (...) propels the discovery of scientific laws.” However, while the first of these assertions is always true, the second is not necessarily valid. The focus on this connection can be considered, in essence, a strong emphasis on technological progress, that is, innovation-driven policies. What about the latter “institutional innovation“? This refers to comprehensively promoting systemic reforms in three areas: science and technology, the economy, and government management. Next, “one system” refers to “building a national innovation system.” This means, in essence, that the actors involved in innovation should work together efficiently and network with each other, especially to achieve

69 This index is a number shown in the successive plans, but it is a unique indicator that is not easily understood.

70 The ratio of R&D expenditures to GDP is an indicator that is commonly used in OECD countries, whereas “scientific and technological progress rate,” although defined, is an indicator that lacks universality and is not used in OECD countries.

military-civilian integration and establish a mechanism to allocate innovation resources by clarifying the division of labor between the government and the market. Finally, the "six major changes" refer to (1) a change to "sustainable development led by quality and efficiency"; (2) a change to "development led by innovation factors"; (3) a change to "the high end of the [global] value chain"; (4) a change from "catching up" to "pulling even" and "taking the lead" in innovation capability; (5) a change in resource allocation to an integrated arrangement "taking in [industry] supply chains, innovation chains and funding chains"; and (6) a change in the actors of scientific and technological innovation from "scientific and technological personnel" to "innovation and entrepreneurial interaction between niche and mass groups." The context here is also focused on innovation, and the promotion of basic research as the seed of innovation is not in view.

What, then, are the specific provisions on basic research? They are found in Section 4, "Strategic Tasks." The first step is to "promote innovation in industrial technology," and goals are set in the areas of information network technology, manufacturing technology, agricultural technology, energy technology, resource use and ecological protection, marine and space technology, smart cities, transportation, electric power, etc., health technology, service technology, and disruptive technology.

This is followed by a policy related to the promotion of basic research to "strengthen original innovation." The theme remains the same, that is, to "combine national strategic needs with scientific exploration goals." Its pillars and main contents are described below.

First, the section on strengthening basic and cutting-edge technological development begins with a commitment to "strengthen basic cutting-edge and high-technology research directed at national strategic needs," taking an approach that is extremely innovation-oriented for the promotion of basic research. Furthermore, this section continues with calls to strengthen basic research around issues related to "long-term development and national security," "increase strategic high-technology research efforts; and achieve security, independence and controllability in key core technologies," and finally "accumulate original resources for technological progress in industries." Therefore, although the following section mentions support for the "free exploration of basic research," the pressure for innovation in the research field appears to be quite strong. Here, we finally come to our main focus, that is, "free exploration of basic research." However, although strong support is indicated at the beginning, and the aims of leading the way in global scientific research and contributing to scientific exploration are positive, instructing researchers to pursue "key breakthroughs" means distancing them from purely exploratory research. Of course, it is commendable that after this, the strategy advocates for the incorporation of new discoveries, new knowledge, new principles, and new methods; balanced development of each field; multidisciplinary work and integration; and the fostering of emerging and distinctive fields. However, for the researcher, these points are in some ways not particularly important to emphasize. Finally, this section is followed by one on research infrastructure development, which is noteworthy. Since China has ample financial resources, it is proposed that a fairly expensive, international-level research infrastructure be developed.

(4) Outline of the Long-Term Objectives through the Year 2035 (-2035)

Chinese policy documents such as the Five-Year Plans are discussed as "proposals" at the fifth plenary session of the

Central Committee[71], which is usually held in October, in the fall of the year before they are adopted. The CPC Central Committee's Proposals for the 14th Five-Year Plan and Long-Range Objectives Through the Year 2035 were approved at the fifth plenary session of the 19th CPC Central Committee, held in late October 2020.

In terms of basic research, these proposals call for "strengthening basic research, emphasizing original innovation, promoting multidisciplinary and interdisciplinary research, rationalizing the structure of academic disciplines and R&D, promoting cross-disciplinary integration, and ensuring a system to supply common basic technology" as a way to "strengthen the nation's strategic competence in science and technology[72]."

Following these proposals, the fourth session of the 13th National People's Congress, which opened on March 5, 2021, approved "The Outline of the 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives through the Year 2035" (abbreviated as "14th Five-Year Plan" or "National Economic and Social Development," etc., below when referring only to the first half; same for other Five-Year Plans). China's long-term plans listed in this chapter, including those for science and technology, have been formulated separately from the so-called Five-Year Plans. In this outline, however, the Long-Range Objectives through the Year 2035, that is, the medium- to long-term plan that is the premise for the 14th Five-Year Plan, is integrated with the Five-Year Plan. Below is an overview of the Outline of the Long-Range Objectives through the Year 2035.

In a sense, the long-term goals in this outline are different from the previous long-term goals in that they are included in the 14th Five-Year Plan document and have fewer quantitative and numerical targets. There is no particular mention of basic research, and with regard to innovation, it is stated that "By 2035, China will have basically achieved socialist modernization. By then, China's economic strength, scientific and technological capabilities, and composite national strength will have risen significantly. The economic aggregate and per capita personal income in urban and rural areas will have reached new heights. Our country will have achieved major breakthroughs in key technologies, and it will be one of the most innovative nations in the world." There is no other mention of this topic. Since specific plans and goals beyond this point will depend on the 14th Five-Year Plan itself, they will be introduced as the 14th Five-Year Plan in section 2.7 of this report.

According to JST's Beijing Office[73], at a meeting of non-CPC Democratic Party members of the National People's Congress on March 7, 2021, Wang Zhigang, head of the Ministry of Science and Technology, announced a 10.6% increase in spending on basic research in 2021. He further announced the plan to increase spending on basic research to 8% of total spending in the future, in accordance with the 14th Five-Year Plan for National Science and Technology. This is to be achieved through the Ten-year Action Plan for Basic Research, which will be formulated based on the 2035 Long-Range Objectives[74]. At the same meeting, Dr. Wang strongly agreed that "China has many technological 'bottlenecks' and is lagging behind in basic theoretical research, which is the root of the problem, both upstream and downstream. He also expressed his wish for China to "place more emphasis on scientific issues in production and

71 The Central Committee normally meets seven times per term.

72 JST Beijing Office, [21-003] "14th Five-Year Plan" Proposals of the Fifth Plenary Session of the 19th CPC Central Committee, January 21, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_003.html (accessed July 24, 2021)

73 [21-020] "14th Five-Year Plan - National People's Congress" Policy of Strengthening Basic Research, Beijing Office, JST Pekin Tayori, March 11, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_020.html (accessed June 28, 2021)

74 《王志刚：2020年我国基础研究占研发总经费比重首次超过6%》, 新华网, March 8, 2021, http://www.xinhuanet.com/politics/2021lh/2021-03/08/c_1127181550.htm (accessed June 28, 2021). For the amount invested in basic research, see section 1.3.1.

practical problem and to have research personnel link their own interests to goal-oriented applied basic research." However, even though the terms "basic theoretical research" and "own interests" are used, pure basic research that is not application-oriented is not in view, and the emphasis is on "goal-oriented applied basic research."

(5) Ten-year Action Plan for Basic Research

This action plan has not been developed as of April 2022. CAS's "10 Articles on Basic Research," which will be introduced in Section 2.9, may be considered similar in terms of content. In any case, the contents of this action plan are expected to be of great interest to concretely achieve more in-depth measures for the promotion of basic research in China.

2.4 Five-year plans for national economic and social development and five-year plans for national scientific and technological innovation up to the 13th Plan

Each of the successive five-year plans for national economic and social development is formulated based on a high-level policy. For example, let us look at the 11th Five-Year Plan for National Economic and Social Development (see Figure 1). The basic concept of promoting scientific and technological innovation, especially basic research, is described in the high-level policy, and then briefly touched on in each section.

As shown above, the laws and long-term plans up to this point call for the promotion of basic research, while at the same time clearly demanding that the results of such research be linked to the needs of the nation.

Below, we will examine changes in the provisions of five-year plans for national economic and social development and five-year plans for national science and technology, starting from the 11th Five-Year Plan for National Economic and Social Development.

(1) The 11th Five-Year Plan for National Economic and Social Development (2006-2010)

The 11th Five-Year Plan (original term: 規画), published in March 2006, states that, in relation to science and technology, China will "strengthen independent innovation capabilities and accelerate the development of science and technology education" and that "the most important thing is to strengthen independent innovation capabilities." To this end, the following issues will be particularly emphasized: "the rapid establishment of an innovation mechanism that combines industry, academia, and research led by the enterprise-based market," "the improvement of the market environment for innovation (start-up risk investment, technology transfer and other intermediary services)," "the implementation of fiscal, tax, financial, government purchase, and other policies to support independent innovation," "the continuous introduction of advanced foreign technologies by utilizing global scientific and technological resources," and "the strengthening of intellectual property rights protection." Although the emphasis is on "independent innovation," the fundamental goal is to "introduce advanced technologies from outside the country."

This plan was followed by the 11th Five-Year Plan for National Science and Technology (2006-2010), which was formulated around the same time. The plan lists "independent innovation," "focus on applications," "industrial concentration," "large-scale development," and "international cooperation" as its development principles. The section on independent innovation seems to be the only part relevant to the promotion of basic research. However, the plan also includes a strong statement of leadership for the development of high-tech industries, calling for "enhancing the potential of such fields as information, life, marine, nano, space, and new materials by strengthening basic research, advanced research, and research with high social benefits." There are no descriptions of policies focused specifically on the promotion of basic research.

(2) The Outline of the 12th Five-Year Plan for National Economic and Social Development and the 12th Five-Year Plan for National Science and Technology (2011-2015)

The Outline of the 12th Five-Year Plan for National Economic and Social Development, published in March 2011, is a "grand blueprint for China's economy and society over the next five years[75]." As for previous plans, its main goal is to explain the intentions of the national strategy, clarify the focus of government work, and guide market-driven action.

With regard to science and technology, the following is specifically described in Part VII, "Implementing Innovation-driven Strategies to Make China a 'Country of Science and Education' and a 'Talent Powerhouse.'" The plan sets the following goals with regard to the promotion of basic research:

"Grasp the trends of scientific and technological development; prepare basic research and high-tech research at an early stage; promote significant scientific discoveries and the birth of new disciplines; and achieve a high position in future scientific and technological competition in fields such as material science, life science, space science, earth science, and nanotechnology"; "Strengthen the construction of research platforms for basic research, advanced technology, and fundamental technology, and improve the country's important science and technology infrastructure, enhancing interconnection, openness, sharing, and efficient utilization of the infrastructure, with a focus on original innovation, integrated innovation, and re-innovation through digestion and absorption"; "Steadily increase financial and tax investment in science and technology, expand public investment in basic research, and deepen reform of management institutions for scientific research expenditures"; "Promote the National Key Basic Research and Development Program (973 Program)." In essence, the plan focuses on establishing a basic research system, building a platform for basic research, and expanding investment, and no new measures seem to be presented.

The 12th Five-Year Plan for National Science and Technology (2011-2015) was formulated based on this plan outline.

The 12th Five-Year Plan (2011-2015) states, "For the first time, the Chinese government has tried to focus in earnest on increasing the international competitiveness of R&D for economic development, that is, on laying the foundation for technological competition with advanced countries[76]." The plan sets such goals as raising R&D investment to 2.2% of GDP by 2015 and also establishes 11 "National Science and Technology Major Projects," including the development of a next-generation high-speed wireless communication network and a jumbo jet. The plan also mentions "areas to be strengthened in basic research and advanced research" and states that "basic research and cutting-edge technology research are important foundations for enhancing our nation's unique capacity for innovation and long-term development of science and technology, and are the source of our scientific and technological progress and confidence." Under the title of "Continuing to Strengthen Basic Research," the plan calls for "confronting the country's major strategic needs and actively promoting the intersection and integration of disciplines, aiming to be at the frontier of science worldwide." The plan further states that China will "actively create an academic environment that fosters free exploration and leads interest-driven scientific research to focus on the strategic needs of the nation."

75 Outline of the 12th Five-Year Plan for National Economic and Social Development, https://spc.jst.go.jp/policy/national_policy/plan125/index_125.html

76 *op. cit.,* p. 14

The emphasis here is on meeting "the strategic needs of the nation," even while fostering a stance of ensuring freedom in scientific research and promoting basic research. The plan continues by stating that China will "strengthen strategic development in several scientific frontiers and key directions related to economic and social development, reach breakthroughs in several important scientific problems, achieve many major independent innovations, significantly strengthen and contribute to our country's position and influence in global scientific research," and "lay an important foundation for the long-term development of science and technology." The plan does not stop at simply opening up the frontiers of science but seeks to link science to economic and social development. Incidentally, the plan lists "integrated fields," "advanced research," "solving research problems that constrain economic development," "competitive fields (quantum, protein, stem cell, and nuclear fusion research)," and "exploration of regional ecological zones and accumulation of various scientific and technological data" as basic research fields, indicating the categories of issues that researchers can freely choose from. The emphasis on "solving research problems that constrain economic development" is particularly distinctive.

In November 2013, during the 12th Five-Year Plan, the Xi Jinping administration, which had already substantially begun its work, announced the decisions of the third plenary session of the CPC Central Committee, which clearly presented the "leadership's strong determination to enact reforms." Out of 60 decisions, the theme that was given the most space was economic structural reforms, whereas the only items related specifically to scientific and technological innovation were "establishing institutions to promote innovation and strengthening intellectual property protection" and "promoting deeper integration of the military and civilian sectors in science and technology[77]."

(3) Outline of the 13th Five-Year Plan for National Economic and Social Development and 13th Five-Year Plan for Scientific and Technological Innovation (2016-2020)

The Outline of the 13th Five-Year Plan for National Economic and Social Development, submitted to the National People's Congress in March 2016, is the first five-year plan related to scientific and technological innovation to be issued under the Xi Jinping administration. The outline is composed of the following six main parts: ① General philosophy, ② Innovation, ③ Coordination, ④ Green development, ⑤ Openness, and ⑥ Inclusiveness. Innovation has been upgraded from the 12th Plan Outline and moved to Part II, indicating a greater emphasis on promoting innovation-driven economic growth. The goal of the plan is "to pursue significant breakthroughs in basic and applied research and in strategic advanced fields by 2020, to increase the intensity of R&D investment of the entire society to 2.5% of GDP, to increase the contribution of scientific and technological progress to economic growth to 60%, and to strive to become an innovation-oriented nation and a talent powerhouse."

Accordingly, the "**Basic Principles**" of the 13th Five-Year Plan for National Science and Technology Innovation (2016-2020) begin as follows: "Insist on making catching up and taking the lead faster the focus of development. Grasp the development trends of cutting-edge science and technology, make advance plans and layouts in basic cutting-edge

[77] Sano Junya, "The Direction of China's Structural Reforms as Understood from the Third Plenary Session: Shifting to 'Small Government' through a Review of Authority," Japan Research Institute Review, 2014Vol. 3. No. 13 81, https://www.jri.co.jp/MediaLibrary/file/report/jrireview/pdf/7278.pdf (accessed January 27, 2022)

areas related to long-term development, implement asymmetric strategies[78], strengthen original innovation, strengthen basic research, work hard to achieve originality and uniqueness, comprehensively enhance independent innovation capabilities, achieve leapfrog development in important scientific and technological fields, keep up with and even take the lead in new directions in global science and technology development, and take the strategic initiative in a new round of global science and technology competition[79]."

The "**Development Goals**" are to "Comprehensively increase independent innovation capabilities. Make significant breakthroughs in basic research and strategic advanced technology, significantly improve original innovation capabilities and international competitiveness, and transition from playing catch-up in overall independent innovation capabilities to keeping pace or taking the lead. Increase the intensity of investments in research and experimental development funding to 2.5%, significantly increase the share of basic research in nationwide R&D investments, and increase the proportion of R&D expenditures by industrial enterprises above a certain size[80] to 1.1% of main business revenue[81]." The plan states that the ratio of R&D investment to GDP will be increased and that the share of basic research in investments will be "significantly" increased as well. However, the plan does not provide a target figure for the ratio of investment in basic research to GDP. The 13th Five-Year Plan is also positioned as an initiative to support the implementation of "national strategies[82]," including the "'Made in China 2025,' 'Internet+,' Cyber Superpower, Maritime Superpower, and Space Superpower strategies, Healthy China construction, military-civil fusion development, 'Belt and Road' construction[83], Beijing-Tianjin-Hebei coordinated development, and the development of the Yangtze River Economic Belt." The main goals are "advancing Chinese industry to the mid-to-high end, creating new momentum for development, opening up new spaces for development, and improving the quality and benefits of development[84]."

A second "**high-level plan**"[85] is to "continue to strengthen basic research." The plan aims to enhance "original innovation capabilities," "cultivate innovative strength for important strategies," "continue to strengthen basic research, comprehensive layout, and forward-looking deployment, focus on major scientific issues, propose and lead the organization of major international scientific plans and major scientific projects, strive to lead the world's scientific direction in more basic and cutting-edge areas, and achieve breakthroughs in more strategic areas," stressing the importance of continuously strengthening basic research. Regarding the management of scientific research, the plan calls for "removing the institutional barriers that hinder [practical application] and comprehensively deepen S&T

78 Asymmetric strategy is a form of warfare in which a belligerent group that has difficulty winning using the same tactics as its opponent engages in combat by other means that cannot be anticipated or countered by the opponent (from Wikipedia). In this context, it is believed that China aims to adopt tactics unique to it that differ from those of Japan, the U.S., and Europe in the competition in advanced fields of science and technology.

79 The Japanese translation of the 13th Five-Year Plan for National Science and Technology Innovation is a provisional translation from the New Energy and Industrial Technology Development Organization (NEDO) Beijing Office (URL below). The quotation is from p. 7 of same provisional translation. The following quotations from the relevant sections of this Five-Year Plan are based on the same provisional translation. https://www.nedo.go.jp/content/100903934.pdf (accessed May 31, 2021).

80 All state-owned enterprises and non-state-owned industrial enterprises with annual sales of CNY 20 million or more

81 *Ibid.,* p. 8

82 Note to the above: The Silk Road Economic Belt and the 21st Century Maritime Silk Road

83 The "national strategies" cited above are considered "high-level plans," indicating that these strategies are above the Five-Year Plan for Science, Technology, and Innovation.

84 *op. cit.* (NEDO) Beijing Office provisional translation, p. 10.

85 Note 65.

structural reform. Accelerate management reform for central government science and technology financing plans (special projects, funds, etc.) and strengthen the overall coordination of science and technology resources[86]."

The measures for "Continuously Strengthening Basic Research" are described in detail in the 13th Five-Year Plan for National Science, Technology and Innovation, Part III, Chapter 8[87].

This chapter is related to the strengthening of basic research, especially its positioning, which is the subject of this report. We will, therefore, analyze it with emphasis on the following.

Chapter 8 begins by stating that the government will "persist in facing the major national needs and the frontiers of international science, persist in encouraging the combination of free exploration and goal orientation, strengthen research on major scientific issues, improve basic research institutions and mechanisms, address shortfalls in basic research, strengthen the supply of sources and drivers of innovation, and significantly enhance China's scientific status and international influence." While the goal is to strengthen basic research, in this instance as well, the positioning is characterized by an emphasis on "drivers" of innovation.

The first section of this chapter is entitled "Strengthen Free Exploration and Discipline System Construction." It states that China will be "oriented toward the frontiers of basic research and following the laws of science[88], further increase support for curiosity-driven basic research, guide scientists to combine academic interests with national goals." However, since this document is only a guideline, researchers are expected to match their own academic interests with national goals. Therefore, although curiosity-driven, this research would not necessarily be the free exploration mentioned at the beginning of the document, at least in terms of the psychology of researchers. In this context, the plan calls for "original discoveries" and more "support for non-consensus and transformative innovation research, encouraging questioning traditions and challenging authority, and focus on research that may reshape important scientific or engineering concepts and spawn new paradigms or new fields and new disciplines." The "non-consensus" qualifier indicates that original research should be supported even if there are conflicting views. The implications of "challenging authority" seem strangely conspicuous. Although this is an opportunity to seek substantial quality review and evaluation, rather than a relatively easy formalistic decision to support researchers who have submitted a large number of papers to leading journals, this directive may bring about a kind of tension in the field of research and in the review and evaluation of applications. The instruction to "strengthen the construction of the academic discipline system" is reasonable. The plan further calls for focusing on "basic subjects such as mathematics" and "the continuous development of disciplines," strengthening "the construction of emerging disciplines such as information, biology, and nanotechnology," encouraging "cross-disciplinary research," and promoting "interdisciplinary work and integration." However, when it comes to focusing on "core scientific issues that need to be solved for industrial upgrades and restructuring" and promoting the "development of applied sciences such as environmental science, marine science, materials science, engineering science, and clinical medicine," the emphasis is still on the aspect of promoting basic research that is oriented toward the important needs of the nation. Furthermore, the goal to "further increase the total

86 *op. cit.* (NEDO) Beijing Office provisional translation, p. 12.

87 However, the 13th Five-Year Plan for National Science, Technology and Innovation in footnote 23 above does not include a translation of Part III, Chapter 8. The relevant passages are translated in JST's "Current Status and Trends of Science and Technology in China 2019," pp. 19-20, (https://spc. jst.go.jp/investigation/downloads/r_2019_03.pdf, accessed July 15, 2021).

88 Author's note: The term "scientific discipline" is often used in Japanese translations of Chinese government documents, but the correct term is "scientific law." The word "discipline" implies an ethical requirement, whereas the correct understanding is rather a logic that follows the laws of nature.

number of papers and citations in various disciplines and raise the academic influence of some disciplines to world-leading status" implies that the guidance is still focused on the number of papers and citations. As indicated in the specific opinions that followed the 13th Five-Year Plan, this was a major shift in the content of guidance from quantity to quality. Readers should keep this in mind as we discuss the details below.

The second section is entitled "Strengthen Goal-oriented Basic Research and Cutting-Edge Technology Research." The tone appears to be unchanged from the first section. It is stated that the government will "coordinate advantageous scientific research teams, national scientific base platforms and major scientific and technological infrastructure, push forward investment and strengthen the deployment of goal-oriented basic research and cutting-edge technology research," targeting "the key scientific issues related to China's economic and social development, the frontiers of international scientific R&D, and the scientific basis for transformative technologies in the future." The emphasis is solely on "goal-oriented basic research." This section continues by stating that the government will "focus on basic research for the deployment of major national strategic tasks," "promote the close integration of basic research with the needs of economic and social development," and "provide sources for innovation-driven development." This guidance would make it difficult to pursue basic research that is not linked to economic development. After this, it is stated that China will "enhance the driving force of innovation power against the world's scientific frontiers and future trends in science and technology." Although this is simply a general instruction, it is followed by plans which are more meaningful in terms of policy. Namely, the government will "select major strategic and forward-looking scientific issues that (...) have a good research base and talent reserve for the improvement of sustained innovation capabilities, strengthen the large scientific research organization model featuring original innovation and a systemic layout, deploy key special topics for basic research, and achieve major scientific breakthroughs and seize a commanding position in international scientific development." Selecting "major strategic and forward-looking scientific issues that (...) have a good research base and talent reserve" means, in essence, that China should find areas where it has a competitive advantage. The report goes on to say that "with the goal of achieving strategic leadership in key scientific and technological fields and looking to achieve leapfrog development at the cutting edge of fields with the potential to lead future human life and industrial production," the government will "establish cultivation mechanisms for the basics of transformative technology and science." The country should further "strengthen the deployment of basic research and advanced exploration in gene editing, materialization (...) and other fields, drive the emergence and development of transformative technologies through scientific research innovations and breakthroughs, and provide scientific reserves for China's industrial transformation and sustainable economic and social development in the future." In essence, this is also a strong call for efficiently guiding the selection of basic research topics toward economic development.

The third section is entitled "Organize the Implementation of Major International Science Programs and Scientific Projects." This section calls for the country to "actively participate in major international science programs and scientific projects" "with respect to the needs of China's development strategy and the nation's actual fundamental capabilities and advantages." Again, "the needs of China's development strategy" are prioritized. It is stated that the government will "focus on areas where China has comparative advantage, such as mathematical astronomy, life sciences (...) and study and propose international [large-scale] science programs and scientific projects that may be organized and initiated by China in the next 5 to 10 years." Furthermore, China should "mobilize international resources and forces and, based on sufficient preliminary research, strive to launch and organize a number of new major international science programs and scientific projects" to contribute to the global economy. The international scientific plans proposed by China since the beginning of the 13th Five-Year Plan are indeed worthy of attention.

The meaning of "mobilize international resources and forces" in this passage is extremely important. This wording suggests that China will be taking some kind of international initiative in the future, introducing "resources and forces" in its science and technology planning proposals. This point is also seen as a prelude to the development of the "World Science and Technology Fund" in the 14th Five-Year Plan.

The fourth section is entitled "Strengthen the Construction of Major National Science and Technology Facilities." Focusing on areas such as "energy and life sciences," and "with the goal of improving original innovation capabilities and supporting major technological breakthroughs," the government will "build a number of major scientific and technological infrastructure facilities relying on the layout of universities and research institutes and support research on cutting-edge scientific issues relying on major scientific and technological infrastructure." In doing so, efforts will be made to "strengthen operation management," "promote the close integration of major scientific and technological infrastructure such as large scientific installations and national laboratories," "strengthen the performance evaluation of major national science and technology infrastructure such as large scientific installations," and "promote open sharing" of such infrastructures. Nor have "national needs," such as the "ecological security and modern agriculture," been forgotten. The construction of "scientific observation and research field stations," the development of a "national field observation system," and the promotion of "the multi-functional, standardized, and networked construction and operation of scientific observation and research field stations" will be pursued.

The fifth section is entitled "Carry Out Major Scientific Studies and Investigations." The government will "organize major scientific studies and investigations across disciplines, fields, and regions and acquire a number of basic, public service-oriented, systematic, and authoritative scientific and technological resources," oriented toward "important scientific issues, sustainable agricultural development, ecological restoration and reconstruction, natural disaster prevention and mitigation, the protection of national rights and interests, and major strategic needs." However, the need to prioritize "basic, public service-oriented" research when investing resources and capabilities in various scientific studies means that projects cannot be pursued solely on the basis of academic interests. The government will further "carry out scientific studies and investigations, observe natural backgrounds and dynamic changes, and provide support for original innovation; major project construction; and national decision-making" in "China's important geographical areas; typical ecological environment areas; international economic cooperation corridors; and polar, oceanic, and other key, special, and uninhabited areas." The wording of this section suggests that such observations and studies are ultimately expected to contribute to innovation and even "national decision-making."

The sixth section in question is entitled "Strengthen the Coordination[89] of Basic Research." The government will "improve basic research investment mechanisms, increase the share of basic research in the nation's R&D investment, give full play to the primary role of the state in basic research investment, increase the central government's support for basic research, increase stable support for basic disciplines, basic research bases, and major basic science facilities." In essence, "investment" refers to financial support, which is to be strengthened, meaning a relative increase in financial support for basic research. However, quantitative targets for this "investment" are not yet defined in this plan (see the discussion of financial support relationships in Chapter 3 for more on this point). Subsequently,

89 In the phrase "coordination guarantee," the word "guarantee" means, for example, to protect a certain condition from being damaged under certain circumstances. While it is somewhat unexpected to see this used in connection with the promotion of basic research, it appears frequently in translations of Chinese government documents. Here, it is considered to mean to ensure that the necessary measures are taken to ensure that the required steps are carried out.

the government will “strengthen the system designs of the policy environment, institutional mechanisms, scientific research layout, and evaluation orientation and take various measures to support basic research” and “actively guide and encourage local governments, enterprises, and social forces[90] to increase investment in basic research and join forces to have the whole society focus on and support basic research.” Although these measures refer to the “layout” of research, they seem to express a rather proactive meaning, calling for the effective deployment of resources. In any case, it is stated that the national government, local governments, and enterprises will strengthen their financial support. The subsequent plan to “strengthen the top-level design and overall layout, improve the communication and coordination mechanisms between national basic research management departments, and systematically deploy and support basic research in accordance with the new national science and technology planning system” is somewhat difficult to understand. This indicates that balance should be considered not only at the top level but also overall, that basic research management departments should communicate with each other, and that a national science and technology planning system should be established and managed systematically. This is a very challenging management approach. With regard to the NSFC, it is stated that it will “play its important role in the support of innovation sources, show ample respect for the academic sensitivity of scientists, tolerate and support non-consensus research, and construct a relaxed and inclusive academic environment.” However, is it not the goal of the NSFC to promote “pure” basic research, in a sense? The emphasis on “role in the support of innovation” under the rubric of “respect for the academic sensitivity of scientists” may be putting too much pressure on researchers to innovate. This passage also contains another mention of “non-consensus research,” meaning that the NSFC is instructed to support research even on issues where there is no consensus. This is followed by a policy of using “National Key R&D plans and special base and talent projects to strengthen support for the development of goal-oriented basic research and collaborative innovation and establish an effective mechanism for concentrating basic research tasks in accordance with national goals and provide long-term stable support.” This implies that research without clear goals or results would not be easily selected. Most importantly, the government will “support independent research (...) of universities and research institutions, expanding the academic autonomy of universities and research institutions and the rights of individuals to select research topics; support a number of high-level universities and research institutes in their formation of interdisciplinary and comprehensive scientific research teams; promote the full participation of universities and research institutes in basic research; and promote the comprehensive, coordinated, and sustainable development of basic research.” However, although “independence” is emphasized, that does not mean that researchers have “free” choice of subject matter. This section ends with plans to “improve the academic environment and establish an evaluation mechanism that complies with the characteristics and laws[91] of basic research; have free-exploration-type basic research adopt long-term evaluation mechanisms, implement international peer assessment, and primarily evaluate the originality and academic contributions of research; have goal-oriented basic research emphasize the degree of goal achievement and primarily evaluate its effectiveness in solving major scientific problems; and establish a system of evaluation guidance built around innovation quality and academic contributions.” The wording of this passage is rather subtle. Although free-exploration-type basic research is advocated, its constant combination with plans to “primarily evaluate the originality and academic contributions of research” in itself puts significant pressure

90 In socialist China, this is an abstract expression that means “the power of the people and the cooperation of all sectors of society” and is used with the nuance of “everyone working together” or “demonstrating the power of society.”

91 Same as footnote 89.

on researchers.

Part III, Chapter 10, of the 13th Five-Year Plan is devoted specifically to plans to “Accelerate the Cultivation and Formation of a Team of Innovative Talent.” This chapter includes a section entitled “Improve the Classification, Evaluation, and Incentive Mechanism for Scientific and Technological Talent,” which touches on the evaluation of human resources in the field of basic research. Regarding the evaluation of personnel involved in basic research, among measures to “Improve the Classification, Evaluation, and Incentive Mechanism for Scientific and Technological Talent,” the government will “improve talent evaluation and assessment methods; emphasize character, ability, and performance evaluations; and implement the classified evaluation of scientific and technological personnel,” “exploring peer review systems for the representative work of basic research scientists, enhance the role of international peer review,” and “appropriately extend the evaluation and assessment cycles for basic research talent.” Regarding “international peer review,” it is important to understand the actual situation, that is, different kinds of international researchers and the diverse methods they use to conduct reviews. In terms of evaluation, this section states that the government will “improve the evaluation system of scientific and technological personnel titles“; reasonably divide and assign the authority to review titles; and promote independent evaluation by higher education institutions, scientific research institutes, and so on. The government plans to “do a good job in organically connecting talent evaluation with project evaluation and institutional evaluation.”

Pay and personnel systems will be reformed to “create rule-based and fair development opportunities for all types of talent” and “improve the income distribution systems of scientific research institutions[92]; promote the implementation of performance-based pay; ensure a reasonable level of pay for scientific researchers; improve the distribution of incentive mechanisms that are closely linked to job responsibilities, work performance, and actual contributions and encourage innovation and creation; and emphasize personnel in key positions and who provide important support for businesses and make outstanding contributions.” This implies the establishment of systems that emphasize performance and contributions. With regard to remuneration, “a variety of distribution methods” will be explored, “such as an annual salary system for heads of institutions of higher learning and scientific research institutes and agreement-based and project-based pay for urgently needed talent and other special talent,” implying that flexible pay systems will be considered. Furthermore, the government will “empower leaders in innovation with greater control over human resources, property, and technology” and the right to determine technology roadmaps “according to relevant laws,” as well as “implement an incentive mechanism oriented to increasing the value of knowledge,” Notably, this is the first mention of granting control and decision-making rights. It will be interesting to see whether this policy will be applied through institutions or frameworks that explicitly target researchers involved in basic research, in particular.

Measures for talent mobility are based on the principle of letting “talent flow freely in accordance with market rules so individuals (...) can make the best use of talent,” and talent and resources can be fully utilized to achieve results. The aim is to “promote the rational flow of scientific research personnel between institutions and enterprises” by formulating “policies and measures for scientific research personnel” who leave their posts to become entrepreneurs, allowing “universities and research institutes to set up a certain proportion of mobile posts,” and attracting “part-time entrepreneurs and technology specialists with innovative practical experience.” The plan states that measures

92 The original term, which literally translates to “research business units,” refers specifically to organizations that, unlike enterprises, have no income from production, are financed by state spending, and are not bound by profit margins (based on a note from NEDO).

will be implemented to "improve the policies governing the transfer and continuation of social security relations when scientific researchers move between enterprises and institutions; facilitate the flow of talent across regions, industries, and systems; and promote the two-way flow of talent." These measures to promote talent mobility within the country are similar to those found in the U.S. Bayh-Dole Act, the French PACTE Law, and others. In response to the international mobility of talent, the government will "implement a more open and innovative science and technology talent policy, explore the mechanisms of flexible intelligence introduction, and promote and guarantee the international flow of innovative scientific and technological talent," "implement a permanent residence management policy for foreigners and explore the establishment of a skill-based migration system," and "carry out innovative activities such as the establishment of technology-based enterprises by high-level foreign talent holding permanent residence permits for foreigners, giving them the same treatment as Chinese citizens, relaxing position restrictions for foreign personnel in scientific research institutions, and relaxing the conditions high-level foreign scientific and technological talent must meet to obtain a permanent residence permit for foreigners." With regard to the foreign student system, the plan aims to "support mechanisms for international student training," "raise government scholarship funding standards," "optimize the structure of international students," and "encourage and support the participation of foreign students and overseas students in innovative entrepreneurship activities in various forms." Efforts are also being made to further eliminate barriers to the introduction of foreign talent.

Part VI of the 13th Five-Year Plan is devoted to "Comprehensively Deepening Science and Technology Structural Reform," that is, the reform of science and technology management overall, including basic research. The first chapter, Chapter 18, is entitled "Fully Promote S&T Management Structural Reform." It states that the government's function as an "innovation governance mechanism" is to achieve "the transformation of the function of the government from R&D management to innovative services, deepen S&T planning and management reform, strengthen the construction of the basic system of science and technology innovation management, and comprehensively improve the ability and level of innovation services." In essence, the science and technology management system will be reformed with an emphasis on promoting innovation. In other words, this refers to strengthening the government-managed promotion of innovation.

At this point, the plan specifically clarifies the functions of the government in relation to those of the market. It states that the fundamental principles are to simplify administration, delegate authority, coordinate relaxation and stringency, and optimize service reform. The plan further states that priority support will be provided to public science and technology activities in basic cutting-edge fields where the market cannot effectively allocate resources, projects of public interest, critical basic core technology research, and more. In other words, the government's function is to support basic research and other fields of study where the market cannot have a leading role. It is quite difficult to understand the meaning of thoroughly applying market concepts to the framework of R&D and scientific and technological innovation. One idea would be to apply the principle of competition in various institutional aspects, ensuring transparency and fairness, although it is unclear whether this would work for basic research. It will be interesting to see whether the above focused support activities can be reliably organized in China, which does not have a typically functioning market, and how they can be reconciled with the government's orientation toward government-controlled innovation. More specifically, the plan proposes to "scientifically divide the scientific and technological authority of central and local governments" and to support policy making through science and technology consulting. Consulting services will regularly report to the CPC Central Committee and the State Council on national and international trends in science and technology innovation and will provide information and submit opinions on critical innovation issues.

In addition, to promote the reform of central government science and technology financing plans (specialized projects, funds, etc.), the government will “restructure the national science and technology plan in accordance with the five types of science and technology plans[93],” including “the National Natural Science Foundation of China” and “the National Science and Technology [Major] Projects.” The government will further “implement categorized management and categorized support,” “integrate all science and technology plans (...) into a unified national science and technology management platform, improve the operation mechanisms for inter-ministerial joint meetings on national science and technology plans (...), strengthen the management of scientific and technological plans and the overall coordination of major events, and give full play to the role of industries, departments,” and the judiciary. Furthermore, the government will “create an innovative design of the whole chain from basic frontiers and major general-purpose key technologies to application demonstrations and practice integrated organization and implementation.” These reforms are quite complex.

With regard to the fund management aspect, the government will “establish an efficient and standardized management system,” simplify “budget and financial management methods to manage scientific and technological resources,” and “make funding serve people’s creative activities.” The plan also aims to establish a financial assistance system for scientific research, improve indirect cost management for scientific research projects, and grant the institution undertaking a project the right to adjust its budget. In addition, the plan proposes the improvement of the coordination mechanism between stable and competitive support, the expansion of stable support, support for research institutions to enact independent scientific research projects, the expansion of the autonomy of higher education institutions and scientific research institutes and the right of individuals to choose scientific research topics, and the establishment of institutions to approve and support non-consensus innovation projects. The mention of the “coordination mechanism between stable and competitive support” touches on the basic question of the balance between so-called institutional subsidies and competitive funding. How to achieve this balance is a question that is constantly being asked in Europe and the U.S. Policy makers need to take a medium- to long-term perspective on this issue. This question is different from the issues of promotion of basic research and freedom of scientific research and will be further discussed in section 2.11.

Meanwhile, proposals related to evaluation systems form the section entitled “Improve Innovation-Oriented Evaluation Systems,” whose content overlaps with the abovementioned Chapter 10 of Part III. This section states that the government will “establish a classification and evaluation system guided by the quality, contributions, and achievements of scientific and technological innovation and correctly evaluate the scientific, technological, economic, social, and cultural value of scientific and technological innovation achievements.” Moreover, it is clearly stated that “evaluation results” will be used “as an important basis for government funding for science and technology.” Third-party evaluations will be conducted, and measures will be taken to “explore the establishment of evaluation mechanisms involving the government, social organizations, and the public” and “expand social, professional, and international evaluation channels.”

93 There are five categories of competitive funding provided by the central government: National Natural Science Foundation of China, National Science and Technology Major Projects, National Key R&D Program of China, Technology Innovation Guidance Program (Fund), and Base and Talent Program. The details of the latter two are unclear, but the first three are detailed in “R&D Strategies of Major Countries (2021)” by the JST Center for Research and Development Strategy (CRDS).

The above is an overview of the specific measures to "promote basic research" in the 13th Five-Year Plan, including the positioning of basic research, financial support, human resource evaluation and development, and science and technology management. While there are improvements in the freedom of researchers and research institutions to choose their own projects, and in the degree of financial and managerial freedom, the basic vision is undoubtedly one in which the government thoroughly manages the process from basic research to innovation and promotes research projects that greatly contribute to social and economic development. In other words, this appears to be a framework that promotes basic applied research, rather than incorporating research based entirely on the free ideas of researchers, which is the source of the power to make new discoveries. This will be discussed in more detail after further analysis of the government documents that will be presented later, which thoroughly implement measures that go even further into basic research.

2.5 Additional policy documents related to basic research promotion and scientific research management reform during the 13th Five-Year Plan or until the end of 2021

The 13th Five-Year Plan has now been implemented, and several documents have been issued during the implementation phase. Even before the 13th Five-Year Plan, numerous documents were formulated and issued by State Council departments and local governments, among others. We have not studied all of these documents, and there is no need to cover them exhaustively. However, we will focus our analysis on documents formulated by the central government that are particularly relevant to basic research promotion and scientific research management reform. See Figure 1 for overall chronological relationships and other details. Science and technology policy was previously drafted by the Ministry of Science and Technology and published by the State Council. Since 2016, however, the process of formulating the policy has been unified, and the policy is now formulated jointly by the Minister of Science and Technology, serving as chair, and the Ministry of Finance and the National Development Commission, serving as vice-chairs.

First, the policy documents on the promotion of basic research include "Opinions of the State Council on the overall strengthening of basic scientific research," dated January 31, 2018, during the 13th Plan, and the December 24, 2021, amendment to the Progress of Science and Technology Law.

Subsequent government documents on scientific research management reform include the following: March 23, 2015, "Opinions on accelerating the implementation of the innovation-driven development strategy through deepening reform of systems and mechanisms"; July 31, 2016, "Opinions on further development policies, including management of funds for scientific research projects funded by the central government"; May 30, 2018, Central Office of the Communist Party of China and Central Office of the State Council, "Opinions on further strengthening credit building in scientific research"; July 18, 2018, "Notice of the State Council on measures to optimize scientific research management and enhance scientific research performance" (State Council [2018] No. 25); June 11, 2019, Central Public Affairs Office and Public Affairs Office of the State Council, "Opinions on further promoting the spirit of scientists and enhancing work and study styles"; August 2, 2021 "Guiding opinions on improving the evaluation mechanisms for scientific and technological achievements" (State Council [2021] No. 26); and August 13, 2021, "Opinions of the Central Office of the State Council on the reform and improvement of fund management for scientific research funded by the central government." We will now cover these documents one by one.

We will describe the characteristics of these documents and further compare them with each other to analyze the

Chinese government's ideas on measures for basic research promotion and scientific research management reform.

In addition, although this is not a policy document, at the end of this section, we will analyze General Secretary Xi Jinping's "Remarks at the 20th Congress of Academicians of the Chinese Academy of Sciences, the 15th Congress of Academicians of the Chinese Academy of Engineering, and the 10th National Congress of the China Association for Science and Technology[94]" on May 28, 2021. These remarks were delivered before the 14th Five-Year Plan for Science and Technology Innovation was announced, and they deserve special attention as they convey the contents of the plan to the leaders concerned.

In addition to the above, two more documents will be introduced in Chapter 3 and discussed with respect to scientific journals and papers: Notice of the Ministry of Science and Technology, "Measures to eliminate the erroneous 'paper only' mentality in science and technology evaluation (trial)," issued on February 17, 2020, and Ministry of Education and Ministry of Science and Technology, "Opinions on the appropriate use of SCI-related indicators and re-orientation of research evaluation in the regulation of higher education," issued on February 20, 2020.

As above, Chinese policy documents will be quoted verbatim as far as possible rather than summarized. The vocabulary and rhetoric used in these documents embody the ideology of the CPC Central Committee; the intended meaning of these documents may not be conveyed accurately and fully if they are summarized. The logic of these documents is sometimes opaque and redundantly constructed, but we ask readers to review them patiently. CPC documents are said to be quite difficult even for Chinese people to understand. However, after reading them many times, we feel that the true meaning conveyed by the Central Committee has become clear to us, as though a spell had been lifted.

Let us begin with documents related to the promotion of basic research.

(1) Policy documents on the promotion of basic research

① January 31, 2018, "Opinions of the State Council on the overall strengthening of basic scientific research[95]"

First, the purpose of the first opinions can be broadly summarized as follows:

"Basic scientific research in China is clearly insufficient for the construction of a science and technology superpower," and there is a "lack of investment in basic research, with few significant and original achievements." The Introduction states that there is a "shortage of talent and teams, a need for evaluation and incentive frameworks, and a need to further optimize the environment that supports basic research throughout society." Next, the Guiding Ideology includes "aiming for the cutting-edge of global science and technology, strengthening basic research, deepening the reform of science and technology institutions, and promoting comprehensive innovation and development in basic and applied research." The Guiding Principles are as follows: "Following the laws of science and classified guidance"; "Respecting the instantaneous nature of inspiration, the voluntary nature of methods, and the indeterminacy of approaches in scientific research, fostering an environment and culture conducive to innovation and encouraging

[94] Founded in September 1958 through the merger of the All-China Federation of Natural Science Societies and the All-China Association for Science Popularization, the Chinese Association for Science and Technology is a large organization of Chinese scientists and engineers, consisting of several national professional associations and hundreds of chapters at various regional and international levels.

[95] 国务院关于全面加强基础基础科科学研究的若干意见 国发〔2018〕4号, issued January 31, 2018
http://www.gov.cn/zhengce/content/2018-01/31/content_5262539.htm (accessed May 31, 2021)

scientists to think freely, formulate bold hypotheses, and earnestly seek proof"; "Encouraging the organic combination of free exploration and goal-directed guidance. Focusing free exploratory basic research on investigating unknown scientific issues and boldly aiming for new heights in science"; and "Firmly linking goal-oriented basic research to the needs of economic and social development and strengthening forward-looking planning in strategic areas."

The theme of this opening section is, in essence, to classify basic research into the above two categories and to reaffirm the importance of "goal-oriented basic research," that is, "basic research based on the needs of economic and social development." The use of the terms "voluntary nature of methods," "indeterminacy of approaches," and "free exploration" in this passage is significant. The guiding principle is to contribute to economic and social development through innovation. Various terms are used in the latter part of these opinions. For example, the earlier emphasis on "stable support" is repeated in the form of "further increasing stable support for basic research in central government funding and establishing diversified mechanisms for basic research investment." In the context of promoting interdisciplinary integration, the opinions mention the importance of fields such as quantum science and brain science and call for "strengthening applied basic research and strongly promoting key fundamental technologies (...) around the critical needs of economic and social development and national security." As always, the term "applied basic research" is repeatedly used. To "optimize the mechanism and environment for basic research development," the government will "strengthen unified planning and coordination of top-level basic research design," "establish a basic research strategic advisory committee to review and judge the development trend of basic research," "establish diversified investment mechanisms for basic research," "further deepen scientific research project and fund management reforms," "implement the autonomy of corporate enterprises and scientific researchers in the use of expenses," and "promote the integration of basic and applied research," and adopt a policy of building "high-level research centers (national laboratories and basic research and innovation centers)." The government will give "national laboratories" "missions, conditions, and support" in "strategic areas with leading potential"; "select the most outstanding and advantageous innovation units"; "integrate national innovation resources, gather top domestic and foreign talents"; "seek to establish an organizational format for scientific research associations"; and "embody the national will in the cultivation of key strategic scientific and technological capabilities that will lead development at a world-class level." In other words, China will concentrate human and financial resources on topics where it can take the lead, create an exceptional environment, and build teams with national prestige.

However, this series of expressions can only mean that guidance is being given to combine basic research and applied research in the field. As for evaluation, it is stated that the government "will establish and develop evaluation mechanisms that fit the characteristics and laws of basic research" and that the evaluation itself will be classified and conducted as follows. In the case of free exploratory basic research, the government "will mainly evaluate the originality and academic contribution of the research and explore long-term evaluation and international peer review." For goal-oriented basic research, the government "will mainly evaluate effectiveness in solving key scientific problems, strengthen process evaluation, establish supervision and management mechanisms with long-term effectiveness, and enhance the efficiency of innovation." In connection with evaluation, it is stated that the government will "support universities and scientific institutes/institutions in conducting basic research independently, and expand the academic autonomy of universities and scientific institutes/institutions and the right of individuals to choose their own scientific research topics."

These passages show that while the terms "free" and "independent" are used and basic research is classified into exploratory and goal-oriented, integration between basic research and applied research is being promoted. Ultimately, we can infer that the research field may be under considerable application pressure, that is, pressure to create innovation.

② January 21, 2020, “Guidelines for activities to strengthen basic research and achieve ‘Zero to One’”

Whether or not it was for the reasons mentioned above, on January 21, 2020, the government resolved to “thoroughly and further put the aforementioned opinions into practice” and issued the “Guidelines for activities to strengthen basic research and achieve ‘Zero to One’” to solve the problem of lack of originality in Chinese basic research results and foster radical innovation (“Zero to One”)[96].

The “basic understanding” of these guidelines is that “international competition will shift to competition in basic research; scientific research will expand to a broader scope and go deeper into the microscopic world; the integration and aggregation of various disciplines will accelerate; significant breakthroughs will be achieved on some fundamental scientific issues; and new and more significant scientific ideas, scientific theories, and disruptive technologies will emerge in the future.” This perception is probably correct, as the concept of so-called “disruptive innovation” has been demonstrated in Europe and the United States, as well. Original breakthroughs that achieve “Zero to One” require wide-ranging knowledge continuously accumulated over a long period of time, as well as the instantaneous inspiration of scientists. Therefore, the government must “go a step further, highlighting the key points and determining what is necessary and what is unnecessary.“

The Guiding Ideology remains President Xi Jinping’s “socialist ideology with Chinese characteristics for a new era.” Furthermore, in line with “national strategic needs,” the “people-centered approach,” “environmental optimization,” and “stable support” will continue, while basic research will “aim for originality and stimulate the energy of scientific researchers for innovation.” Emphasis is also placed on adapting to “national strategic needs.”

Let us now look at the Basic Principles of the guideline. The opening line, “Aiming to address outstanding issues,” is typical of CPC phraseology. In essence, this document will “take the needs of national strategy as a starting point,” “strengthen the placement of priority areas,” and “encourage interdisciplinary research.” Again, the term “national strategic needs” is repeated here. The “people-centered approach ” is underscored, and “methodological innovation” is emphasized. This is followed by “academic environment optimization” and “stable support.”

The guidelines are characterized by the repeated use of the terms “freedom” and “independence.” However, under “academic environment optimization,” they set the goal of “strengthening the creation of an academic culture.” The guidelines call for “advocating academic freedom and democracy; adhering to a good, sincere, truth-seeking approach; avoiding a careless and frivolous atmosphere as much as possible; establishing honest, sincere, and correct instruction; being dedicated to patriotism and the nation; sincerely upholding trust; and promoting a scientific spirit that does not emphasize fame and profit.” The term “academic culture” is used here for the first time. The phrase “being dedicated to patriotism and the nation” calls for an attitude that goes beyond mere academic culture, a pressure somewhat alien to “academic research,” which is supposed to be unbound by anything. As an expression related to basic research promotion, it sounds somewhat different from previous mentions of so-called “academic freedom.” The

[96] Ministry of Science and Technology et al. 门印发《加强“从0到1“基础研究工作方案》January 21, 2020, http://www.cac.gov.cn/2020-03/04/c_1584872637385792.htm (accessed May 31, 2021) (underlined parts in the translation are author’s notes)

aspect of "integration with applied research" emphasized in the abovementioned January 2018 opinions has also been diluted. For example, under "environment optimization," the aim of "establishing an evaluation system that encourages fundamental innovation" remains the same. However, it is stated that the emphasis will be on "the academic content of papers, avoiding the tendency to focus on papers, titles, academic background, and awards." It is then stated that "the new evaluation system for State Key Laboratories" will "adhere to the periodic evaluation and classified review system" and that "important evaluation criteria" will include "the status of accomplishing national missions" and "the effectiveness of innovation," with application-oriented goals being placed in a subordinate position. Although this point indicates a kind of shift in basic research promotion, the classification of "basic research projects" and "basic research application projects" and the evaluation system based on this classification remain unchanged. In other words, the evaluation of basic research projects is focused on originality and scientific value, whereas the evaluation of basic research application projects is "focused on their role and applied value in solving scientific problems that are key to economic and social development and critical national security needs." Further, albeit being a late development, it is stated that higher education and other institutions will be supported in planning their own basic research and will be granted the right to select their own departmental assignments and scientific research topics.

In addition, in relation to the NSFC system, "support for priority basic departments such as mathematics and physics will be strengthened," the direction of "free exploration" and "highlighting originality" will be reinforced, and the "free selection of topics" will be encouraged for general and other projects. Particular attention will be paid to the reduction of barriers to potential implementation, the acceptance of applications without deadlines, and so on (this point will be separately examined in section 5.4 as part of the NSFC reforms). However, these measures also aim to "firmly link researchers' own areas of interest with the demands of national strategy" and "improve the overall capacity for fundamental innovation." This is unlikely to create a situation in which basic research unrelated to "the demands of national strategy" takes center stage.

The National Technology Program states that the government will "highlight support for important original directions" and for "critical scientific challenges in key core technologies[97] (...) over the long term."

Although not found in the abovementioned January 2018 opinion, the reform of the "formation mechanisms of Key Basic Research Projects" will address "the formation style and management methods of basic research projects in terms of guide creation style, effective competition, openness, project review mechanisms, formation of review expert teams, and so on." The government will place "great emphasis on inspiration in the process of scientific research and establish a green channel policy for application, evaluation, and review of original projects, as well as a mechanism to apply at any time." While accepting applications at any time is quite commendable, the definition of "Key Basic Research Project" is unclear. Further, although the phrase "inspiration in the process of scientific research" had been used in the past, this is not the same term for "inspiration" that was used in the January 2018 opinions. A faithful translation of the Chinese term used in this document would be "an instantaneous flash of inspiration." It is a somewhat literary expression, and it is unclear whether this provision will allow researchers to choose research projects freely based on their own ideas.

97 The areas of focus are "artificial intelligence, network collaborative manufacturing, 3D printing and laser manufacturing, key basic materials, advanced electronic materials, structural and functional materials, manufacturing technologies and key components, cloud computing and big data, high-performance computing, broadband communications and new types of networks, Earth observation and positioning systems, optical and electronic devices and optical integration, biological reproduction, high-end medical instruments, integrated circuits and microwave devices, and critical scientific equipment and facilities."

International cooperation in basic research will be advanced, and “more efforts will be made to open up national science and technology programs and to have foreign experts take the lead in national science and technology program projects,” indicating that this issue is considered just as important as in the past.

The policy to foster human resources for basic research is to “accelerate the development of influential leaders in frontier fields around the world and to grant these leaders the right to develop technology roadmaps, decide how to spend project funds, and form innovation teams.” This very proactive approach is a new policy that was adopted from the 13th Five-Year Plan onward. In relation to education, the government will “promote educational reform, reform training styles, and foster the spirit of science and creativity in a consistent manner throughout the entire educational process.” However, this is hardly something that needs to be stated deliberately through CPC guidelines. In addition, through the “implementation of long-term projects for young scientists,” support will be provided to outstanding young scientists who intend to engage in scientific research for a long period of time. These young scientists will be selected “upon recommendation by a leading scientist.” They will “plan a project based on the direction of focus,” and “the project director will independently determine the research and technology roadmap.” The guidelines also propose an “annual stipend system.” Increased support for young scientists in the National Technology Program, the National Key Technologies R&D Program, and the National Natural Science Foundation of China is called for as well.

The “methods and tools of scientific research” innovation will include strengthening R&D for “critical technology infrastructure” and “high-end common scientific equipment,” using these activities as a vehicle to create top-level scientific research teams and to promote the rapid development of industries related to these instruments and equipment and supporting the “independent development of scientific research tools.” This expectation for the “development of industries related to instruments and equipment for scientific research” is a new policy, not found in the January 2018 opinions.

Regarding “State Key Laboratories,” the opinions focus on their “traction role” and state that the government will “seek to create a mechanism for them to apply as independent responsible entities and take on the national technology mission,” contributing to “foster the capacity for continuous innovation in the areas of key departments and key technologies” and emphasizing “highlighting originality, long-term accumulation, and frontline research.” It is further stated that “enterprises will be encouraged to collaborate with higher education institutions to strengthen basic research and develop basic research talent. In the process of debating and implementing major specific items and priority R&D plans, entrepreneurs and industry experts will cooperate with technology experts to identify key scientific problems that exist at the frontlines of production or are related to economic and social development, and support enterprises in undertaking national scientific research projects.” In this way, enterprises are required to identify and address scientific issues close to production sites. The importance of promoting basic research conducted by enterprises was pointed out in the January 2018 opinions; these guidelines clearly state the commitment to establishing “State Key Laboratories” for enterprises and enhancing the National Natural Science Foundation of China institution.

As for “strengthening management services,” the measure to “launch a specialized committee for strategic consulting on basic research” is particularly noteworthy. In the 2018 opinion, this was to be the “Strategic Consulting Committee for Basic Research.” In essence, this committee will “lead the way in top-level basic research,” “pursue unified coordination,” “identify trends in basic research development,” “identify critical needs of basic research,” and “plan critical tasks.” It is further stated that “various technology plans will formulate and create unified support policies and management mechanisms to support basic research.” In a sense, this system is based on the idea of a party-led approach to designing and conducting basic research in a very efficient manner.

Finally, with regard to financial support, these guidelines continue to call for the coordination of stable and competitive support. The government will "strengthen stable support for basic research through central government funding and establish funding mechanisms that balance sound and stable support with competitive support. The central and local governments will seek to adopt new mechanisms to jointly fund and plan national key basic research missions."

③ December 24, 2021, amendments to the Progress of Science and Technology Law

As mentioned in section 2.2(3), this amendment to the Progress of Science and Technology Law established a separate chapter on basic research, arguably clarifying the national policy on basic research promotion. In this section, we will review this policy and provide a content analysis.

Chapter 2, Article 19 of the law states, "The state enhances the capacity of basic research; strengthens the overall planning for research projects, talent, and bases in alignment with the inherent laws of scientific development and talent growth; and provides good material conditions and strong institutional guarantee for basic research [and development]." Noteworthy in this set of rules is the combination of "basic R&D." The subsequent provision states, "The State shall strengthen planning and arrangements, promote the organic combination of free exploration and goal orientation in basic research, centering on the frontiers of science and technology, economic and social development, the major needs of national security, and the life and health of the public, with a focus on major key technological issues, strengthen basic research in emerging and strategic industries and other fields, and enhance our capacity for supply at the source or S&T." In other words, the legal framework stipulates that basic research must be free exploration but must also be goal-oriented and organically combined. Even if encouraging companies to increase their investment in basic research (Article 20) is considered a good strategy, one can imagine that such encouragement would occur within this framework. It is also notable that regarding academic disciplines, "the state improves the structure of academic disciplines and the knowledge system, promotes cross-disciplinary integration, and facilitates the coordinated development of basic and applied research" (Article 22). Further, the law only stipulates the pairing of basic research and applied research. Particularly noteworthy is Chapter 3, "Applied Research and Commercialization," which states, "The state encourages applied research that can give impetus to basic research and promotes the integrated development of basic research, applied research, and commercialization of research results" (Article 26). This is a position that may cause some difficulty in classifying basic research and applied research.

In relation to the 8% target for R&D investment in basic research, which is one of the goals of the 14th Five-Year Plan that will be introduced below, the amended law stipulates that "the proportion of expenditure on basic research in the gross domestic expenditure on R&D shall be gradually increased to meet the requirements of building China into a powerhouse of science and technology" (Article 20). Many countries across Europe, the U.S., and Japan have set a total R&D investment target of 3% of GDP. Instead, this law stipulates, "The state gradually raises the overall level of investment in science and technology. The state's fiscal investment in science and technology shall increase faster than the growth rate of the state's regular revenue. The gross domestic expenditure on R&D shall account for an appropriate proportion of the GDP and shall gradually increase" (Article 86). Both of these are abstract definitions, whereas targets should be clearly stated as numerical values in basic plans and other similar documents.

Below is a list of documents related to scientific research management reform.

(2) Policy documents on scientific research management reform

① March 23, 2015, “Opinions on accelerating the implementation of the innovation-driven development strategy through deepening reform of systems and mechanisms”

The CPC Central Committee and the State Council decided on these opinions on March 13, 2015, and published them on March 23, 2015[98].

The overall policy and main goals of the opinions are to promote innovation based on demand, to create an environment that is conducive to innovation, and to develop the institutions and laws necessary for innovation-driven economic development by 2020, leading to sustainable development through the free movement of human resources, capital, technology, and knowledge. The key task is to shift the focus to productivity-driven development by stimulating innovation. In a sense, these opinions clarify the policies and goals to be pursued by linking previous innovation-driven economic development to concrete institutions.

Specifically, the following seven measures are presented:

① Creating a level playing field that is conducive to innovation (strict enforcement of intellectual property protection systems, breaking down monopolies and market divisions that constrain innovation, etc.)

② Establishing market-oriented technological innovation mechanisms (e.g., increasing the voice of firms in innovation policy)

③ Strengthening the promotion of technological innovation through financial innovation (e.g., strengthening support for technological innovation through the development of angel investment-related laws and regulations and policy support, strengthening the role of capital markets and indirect finance)

④ Promoting practical application of research results (e.g., accelerating the granting of rights to use and dispose of research results and the rights to profits obtained from the transfer of research results)

⑤ Establishing a more efficient research system (optimizing support for basic research, introducing a performance-linked salary system, etc.)

⑥ Reforming systems for fostering, utilizing, and attracting talent (e.g., building models for fostering innovative human resources, developing and restoring systems to promote the two-way flow of researchers between industry and academia)

⑦ Promoting open innovation with a high degree of global integration (e.g., deregulating international movement of researchers and research materials, pursuing greater openness of science and technology programs to the outside world)

With regard to innovation-driven economic development, the 12th Five-Year Plan (2011-2015) states, “For the first time, the Chinese government has tried to focus in earnest on increasing the international competitiveness of R&D for economic development, that is, on laying the foundation for technological competition with advanced countries.” These opinions further embody the content of the structural development direction provided in Chapter 7 of the Plan, “Implementing Innovation-driven Strategies to Make China a ‘Country of Science and Education’ and a ‘Talent Powerhouse.’” The reforms in science and technology management and institutions that followed until today are presented below, mainly from the perspective of their substantial effects on the promotion of basic research.

98 https://www.mizuho-ir.co.jp/publication/mhri/research/pdf/china-bri/cb150420.pdf (accessed December 22, 2021)

② July 31, 2016, “Opinions on further development policies, including management of funds for scientific research projects funded by the central government”

Various opinions on reforms have been issued since the Xi Jinping administration came to power[99]. Since the opinions expressed on the management of funds for science and technology projects are quite radical, we will begin by introducing various aspects of these reforms.

Recognizing that previous reform measures had not been properly implemented and that there were still deficiencies in the management of funds for scientific research projects, these opinions on reforms proposed to strengthen the central government’s innovation reform, thoroughly implement requirements for a dynamic science and technology management and operation system, and further develop policies such as the management of funds for science and technology projects funded by the central government.

The basic guiding principles of the Communist Party are, of course, stated at the outset. The opinions aim to motivate scientific researchers by simplifying government structures to promote mass entrepreneurship and universal innovation, delegating authority to local administrative departments and lower-level agencies, combining relaxation of restrictions and management, optimizing services, and reforming and innovating cost use and management methods. The specific principles are adherence to the people-first mindset, compliance with regulations, and policy implementation and application, and the integration of reforms to “delegate power, streamline administration, and optimize government services” (*phan guan hu,* original term: 放管服)[100] .

These opinions have several components, the first of which is “Improving the management of funds for science and technology projects funded by the central government.” The first provision is “Simplifying budgeting and delegating budget adjustment authority.” This includes establishing a system to allow for the advance payment of funds prior to the approval of the departmental budget; to guarantee the demand for funds; to delegate budget adjustment authority to host institutions[101], allowing them to adjust certain direct costs on the assumption that the total budget will remain unchanged; to allow budgeting items such as meeting and travel expenses to be merged to meet the needs of researchers; and not to require justification for items that do not exceed 10% of direct costs. The second provision is “Increasing the ratio of indirect costs and strengthening performance-linked incentives.” For projects that use an open competitive bidding method, this made it possible to set indirect costs and increase the ratio to a certain percentage of the amount after deducting equipment and other expenses (specifically, up to 20% for those under CNY 5 million, etc.). The incentive system for scientific researchers was further strengthened, and the performance-linked spending ratio limit was abolished. The third provision is “Clarifying the scope of personnel costs and eliminating percentage restrictions.” This made it possible to pay expenses for graduate students, postdoctoral researchers, visiting

[99] These opinions were preceded by the “CPC Central Committee and the State Council opinions on strengthening structural reforms and accelerating the strategy for the development of an innovative nation” and “Opinions of the Central Office of the State Council on the reform and improvement of fund management for scientific research funded by the central government.”

[100] Since 2016, China’s science and technology institutions have been reformed, and the State Council has issued the following reform measures for central ministries and agencies: (1) “Delegation” (delegating approval and other authority to local governments as much as possible); (2) “Administration” (focusing on supervision, management, and evaluation); and (3) “Services” (providing a better business and R&D environment with a service approach). In short, this policy is often described as “streamlining administration and delegating authority, balancing the strengthening of supervision and management capabilities with the delegation of authority, and optimizing government services.”

[101] This refers to the institution (university or scientific research institute) that receives the funding and implements the project. It can also be called a fiduciary institution.

researchers, research assistants, and other participants in the project; to include the required social insurance subsidies in personnel costs; and to organize the budget for personnel costs according to the actual conditions of the host institution and scientific researchers, with no percentage restrictions. The fourth provision is “Improving the method of retaining and handling surplus funds carried forward.” This made it possible to carry over surplus funds from one fiscal year to the next for the duration of the project. Under this policy, surplus funds can be retained after the project goals are met and an acceptance inspection is conducted; it can be used by the host institution in accordance with regulations, and surplus funds can be used by the host institution for the direct costs of research activities within two years, whereas any unused funds thereafter are recovered. The fifth provision is a reform known as “Standardizing the independent management of non-fiscal science and technology expenditures.” This refers to the independent management of expenditures received by host institutions in connection with projects commissioned by the market, that is, expenditures not involving central government funding, which are to be managed and used in accordance with the requirements and contractual terms of the client.

The second item of the opinions is “Improving travel and conference expense management for government-funded universities and scientific research institutions.” This section presents improvements in the management of travel expenses, simplifying and streamlining the means of transportation, the method of calculation, and the scope of payment. It further improves the management of conference expenses, simplifying and streamlining the fact-based determination and reimbursement of conferences sponsored by scientific research institutions and other organizations, including the number of conferences, the number of days, and the number of attendees.

The third item is “Improving purchase management for scientific research equipment and facilities at government-funded universities and scientific research institutions.” First of all, efforts are made to improve the management of purchases. In other words, each institution is allowed to first purchase property on its own and then select its own evaluation expert. At the same time, the procedures for budget adjustments and review of changes in purchasing methods for purchasing projects are simplified and made public, transparent, and tracked. Imported equipment and facilities are subject to a notification management system and continue to be exempt from taxation.

The fourth item is “Improving infrastructure construction project management at government-funded universities and scientific research institutions.” This item expands management authority over infrastructure construction and requires scientific research institutions and other organizations to decide on their own self-funded construction projects and notify the competent department only, without requiring permits. Meanwhile, the competent department is required to strengthen guidance, supervision, and inspection of construction projects. In addition, the competent department no longer reviews and approves proposals for infrastructure construction projects but provides guidance on the five-year plans formulated by scientific research institutions, and the review procedures for urban construction plans, environmental impact assessments, etc., are simplified to shorten the review period.

The fifth item is “Standardizing management and improving services.” This first requires “strengthening corporate responsibility and standardizing fund management.” Therefore, the decision is made to establish internal management methods for host institutions to strengthen autonomy and self-imposed norms regarding budget review, use of funds, and so on and to establish an internal disclosure system for organizations to voluntarily disclose relevant information on budget, use of funds, research results, and so on. The next requirement is “strengthening comprehensive collaboration and simplifying inspection and evaluation procedures.” This means that the relevant departments should strengthen collaboration systems by clarifying the division of labor and job responsibilities, accelerating the organization and standardization of various inspection and evaluation tasks performed by commissioned intermediary organizations[102], and abolish excessive inspections such as duplicate or multiple inspections. This item also calls for the creation of a service model that allows scientific researchers to focus on their research; for researchers to have access to professional services for budgeting, expenditures, and so on; and for support costs to be covered by project funds. It is also said that the necessary information platform will be established to improve management efficiency and solve problems such as the difficulty in obtaining certain invoices and the cost of responding to requests from foreign guests.

The sixth item is “Strengthening institution building and work management and ensuring the full implementation and effectiveness of policy measures.” Competent departments for projects are tasked with providing guidance to enable the scientific and rational compilation of project budgets by improving budget compilation manuals, and the financial inspection work performed by commissioned intermediary organizations is standardized. The Ministry of Finance and the Ministry of Science and Technology are to conduct monitoring surveys on the measures to be strengthened and perform appropriate reporting, and monitoring results are to be integrated into the credit management system and linked to the assessment of indirect costs, management of surplus funds, and so on, to ensure steady implementation.

③ May 30, 2018, Central Office of the Communist Party of China and Central Office of the State Council, “Opinions on further strengthening credit building in scientific research”

In earlier documents, the Guiding Ideology used the expression “Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory, the Theory of Three Represents, and the Scientific Outlook on Development,” followed by “General Secretary Xi Jinping’s socialist ideology with Chinese characteristics for a new era.” However, the Guiding Ideology of policy documents issued after General Secretary Xi Jinping came to power no longer includes the first of these two phrases. Perhaps, General Secretary Xi Jinping wants to emphasize that his ideology is not just the last in a long line of guiding ideologies by various leaders but rather the one that represents them all.

Putting that aside, the opinions with this title appear to be measures to more systematically and concretely ensure the credibility of scientific research in order to more thoroughly enforce regulations on the prevention and handling of research misconduct, which have long been advocated. The Guiding Ideology calls for “promoting the institutionalization of credit building in scientific research” and “strictly investigating and punishing violations of credit requirements in scientific research.”

The Basic Principles begin with “Clarification of responsibilities and orderly coordination,” stipulate that “Systematic promotion and focused breakthroughs” will be made based on “Clarification of responsibilities of each entity,” call for “Encouragement of innovation and tolerance for failure,” and ensure “Adherence to the bottom line and lifelong pursuit of responsibility.” The bottom line, in particular, is frighteningly strict. The opinions call for “creating a rigorous and self-sustaining institutional environment and social mood, consistently giving opportunities to those who have earned credit and ensuring that those who lose it are subject to restrictions everywhere.” This point implies the formation of a society of mutual surveillance, where individuals are punished to make an example for others, rewards

102 Science and technology intermediary organizations, in central, have grown rapidly since the Ministry of Science and Technology released its “Opinions on the great development of science and technology intermediary organizations” in 2002. They are considered to play an important role in each phase of the R&D system (R&D phase, consultation and evaluation phase, results conversion and commercialization phase). In this case, this term seems to refer to the organization in charge of outsourcing work. Specialized agencies and other information are cited throughout this research report.

and punishments are meted out based on merit, and loss of credibility is permanent.

The main goals are to "effectively operate a credit building mechanism for scientific research that is well supervised and controlled," to "establish and maintain a credit information system for scientific research that is all-encompassing, shared and coordinated, and able to manage trends," and to "make compliance with integrity and credit standards a common principle and conscious action of the science and technology community."

Although the specifics and contents are rather vast, and the language of the Communist Party can be somewhat tedious, we have included some quotes below. First, opinions on the "Improvement of credit management mechanisms and responsibility systems" are presented. These stipulate responsibilities at every level, including the responsibility of the Ministry of Science and Technology and CAS for unified coordination and macro-guidance; the responsibility of local governments at all levels and competent departments in the relevant industries to enhance work capacity and strengthen work assurance, to establish and develop work management mechanisms for science and technology planning and management departments; to integrate credit requirements into the overall planning and management process; and to develop internal controls for departments such as education, health and hygiene, newspapers and publishing; the responsibility of CAS, Chinese Academy of Engineering, and CAST academics to strengthen credit requirements and supervision and to examine credit in recommendations, etc.; the responsibility of each institution involved in science and technology activities to incorporate credit operations in its normal operations and under its own responsibility, and to clarify compliance with credit and accountability requirements for its employees through contracts and others means; the responsibility of scientific research institutions and higher education institutions to clarify duties, accountability, and authority in credit operations to provide the necessary guarantees for operating expenses, etc., to investigate and punish every case of non-compliance with credit requirements by an academic committee, and to review scientific papers and other achievements; the responsibility of agencies specialized in project management to strengthen credit management in project management, among evaluation and review experts, etc., and to strictly investigate and punish non-compliance with credit requirements; the responsibility of scientific researchers to comply with moral standards, credit requirement practices, and the prohibition of fraud, plagiarism, falsification, and fabrication, ghostwriting and proxy submission of papers, and forgery in project and award applications, etc.; and the responsibility of evaluation and review experts to conduct objective and fair work and provide responsible and high-quality evaluations.

The opinions further prescribe a series of specific measures, including "Credit management at all levels," "Further promotion of the institutionalization of credit," "Appropriate strengthening of credit education and publicity," "Strict investigation and handling of serious violations of credit requirements," "Acceleration of informatization construction in credit," and "Safeguard measures." Each of the characteristic aspects will be selected and supplemented here.

First, "Credit management at all levels" stipulates that "recurring inspections of the performance of credit responsibilities will be strengthened" by enhancing routine management and supervision; signing pledges; clarifying processing requirements in the event of violations; implementing a "one-vote veto system" for responsible persons who have seriously violated credit requirements; establishing mandatory procedures for various credit reviews; institutionalizing credit requirements for publishing papers; creating a system of inspection and reporting of scientific research results and thorough retraction measures in situations of non-compliance with credit requirements; and making credit status an important indicator in a system of classified evaluation oriented to the quality, contribution, and performance of scientific and technological innovation.

"Further promotion of the institutionalization of credit" takes the stance of promoting the international improvement of Chinese journals. It aims to "create high-level academic journals" and "prioritize the academic level and social effect of the requirements, raise the influence of our journals, and improve their international voice" by enhancing rules to investigate and handle credit requirements, having the Ministry of Science and Technology and other institutions research the establishment of unified rules for this purpose and creating and improving a management and early warning system for academic journals. This is because it is extremely important to improve the quality of papers and build credit through the review process in order to improve the international standing of academic journals.

"Appropriate strengthening of education and publicity of credit" calls for strengthening education through precepts and discourse in all sectors and strengthening publicity of credit through various means of communication.

In "Strict investigation and treatment of serious violations of credit requirements" and "Acceleration of informatization construction in credit," it is first stated that the Ministry of Science and Technology and CAS shall be responsible for any false statements in papers, etc., and for the implementation of routine supervision and management tasks, from reporting to verification. As mentioned above, serious violations of credit requirements will be punished through the creation of a "lifelong pursuit system" that "maintains a high-handed approach of strict enforcement," cancellation of project application eligibility, recovery of project funds, revocation of honorary degrees, recovery of prize money, expulsion from the academic register, cancellation of degrees and other qualifications, revocation of medical licenses, and other measures. Further penalties will include potentially lifelong cancellation of promotions and titles, application eligibility, appointment as an evaluation expert, and candidacy for graduate degrees, as well as termination of labor contracts and prohibition from engaging in teaching and research work. It is also stated that any conduct that seriously undermines credibility will be entered in a database and added to an observation list. Those in public office will be subject to punishment by law or other means; Communist Party members will be subject to party discipline; and criminal acts will be turned over to judicial authorities. In addition, joint disciplinary action will be taken, and various reviews and evaluations of project applications, appointments, employment, and so on, will be linked to credit status, which will be an important reference for administrative approval, public procurement, priority evaluation, financial assistance, funding grade evaluation, tax credit evaluation, and so on.

As for "Accelerating Informatization Construction in Credit," the plan calls for the establishment of a credit information system to enhance recording, standardization, sharing, and application and to achieve joint disciplinary action.

Finally, there are the usual "Safeguard measures[103]." Here, the emphasis is on strengthening guidance by the Party, constructing a "credit-building target responsibility system," establishing a supervisory inspection and reporting system for the status of credit building, and requiring commendation of departments for outstanding work and reporting and criticism in the event of failure to perform their duties. In addition, this section calls for "demonstrating supervision by society and the leading role of public opinion" and "encouraging responsible reporting of real names" by "society, the public, and the press" regarding "violations of credit requirements" and states that the press "must strengthen positive guidance regarding credit." It also calls for strengthening "monitoring and evaluation," stating that monitoring and evaluation results will be used to improve operations and "will be an important basis for enterprises to receive funding from the government and other sources." Scientific research credit reports will also be published periodically. This section further states that international exchange and cooperation in credit building will be carried

103 Measures that ensure and secure the steady implementation of the reform.

out to "effectively respond to credit events for scientific research in multilateral and inter-district settings."

In summary, these opinions broadly stipulate various requirements for research ethics[104] and research integrity in terms of credit requirements for scientific research; regulate compliance with these requirements as an obligation extending from individuals to organizations; impose strict punishments on violators and violating institutions, including lifelong severe punishments and social sanctions; and establish institutional mechanisms to ensure compliance, including an information management system, mutual control, mutual monitoring, and, in a sense, a mechanism to ensure thorough compliance by encouraging whistleblowing. Although it is hard to believe that criminal acts such as corruption are widespread, one cannot help but feel quite disappointed that integrity in the research field cannot be maintained without such strict regulations.

In Section 7.4, we will evaluate the impact of the Chinese approach to research integrity on the research field, comparing it with that of Japan and the U.S.

④ July 18, 2018 "Notice of the State Council on measures to optimize scientific research management and enhance scientific research performance" (State Council [2018] No. 25)

While this report presents and analyzes documents from March 2015 onward, this July 2018 notice of the State Council covers a comprehensive range of content, including measures taken by previous opinions and anticipated future measures. The main pillars, in addition to reforms to "delegate power, streamline administration, and optimize government services," are reducing the burden on researchers and granting them greater autonomy to stimulate research motivation. This notice also responds to Xi Jinping's speech at the joint Congress of Academicians on May 28 of the same year, in which he stated that "the personnel evaluation system is unreasonable, and the tendency to emphasize only papers, academic background, and titles is still strong." Incidentally, this speech was the first to suggest the abolition of the "four only" (*su wei*, original term: 四唯) system, which placed emphasis on only four nominal achievements. It was followed by a coordinated "initiative to break the four only" by the Ministry of Science and Technology, the Ministry of Education, the Ministry of Human Resources and Social Security, CAS, and the Chinese Academy of Engineering since October of the same year. Subsequently, in the March 2019 Report on the Work of the Government, the government vowed to "reform and improve mechanisms for training, employing, and evaluating capable people and provide better services for students returning from overseas and foreign professionals." (Reforming evaluation mechanisms refers to "breaking the four only.")

Since the specific content of the above State Council notice is comprehensive and varied, the main points, especially those related to "basic research promotion," are explained one by one below.

The first point is "Optimizing scientific research projects and fund management." In particular, this provision aims to avoid duplicate applications for scientific research projects; provide sufficient preparation time for researchers; simplify application requirements; and reduce various evaluations, inspections, and audits. Specifically, free exploratory basic research and other projects will be self-managed by host institutions, and inspections will not be

[104] According to Matsuda Yuna, Fellow, Asia and Pacific Research Center, "[22-01] China has Formulated 'Opinions on Strengthening Ethics in Science and Technology': Consequences for the Development of AI and Genome Editing Technology," Science Portal China, Column & Report, "Measures related to social safety, public safety, biological safety, human life safety and physical and mental health, respect for individuality, and the right to choose and know of participants in scientific research activities were presented in the 'Opinions on Strengthening Ethics in Science and Technology' issued in March 2022." In this sense, the Chinese governments' initiatives regarding research ethics seem to lag behind those of other countries. https://spc.jst.go.jp/experiences/science/st_2201.html (accessed May 4, 2022)

performed. Financial and technical acceptance inspections will only be performed by a "specialized management agency[105]," that is, a third-party intermediary organization independently selected by the host institution to perform a single comprehensive performance evaluation. A "consolidated data notification system" will be established to promote data sharing among relevant organizations and unify all data in the "National Science and Technology Information System" to relieve researchers in particular from financial reporting and other administrative tasks. Researchers will be empowered to determine the research policy and technology roadmap, to organize the research team on their own initiative, and to submit the results of the coordination to the specialized management agency, provided that the applied indicators are not lowered. Host institutions will be granted autonomy in managing and spending research project funds, except for equipment costs. Expenses for projects commissioned by enterprises and other entities will be managed by scientific research institutions. Special procurement procedures will be established for purchases for which only a single source is available or for equipment that requires urgent procurement, and bidding procedures will not be conducted in such cases. By formulating a unified plan for relevant departments and conducting joint inspections, duplicate inspections and multi-agency inspections will be avoided, inspection efficiency will be improved, and interference with scientific research activities will be reduced as much as possible through a review of inspection methods[106].

The second point is "Implementing an evaluation incentive system that encourages innovation." First, this section abolishes the use of personnel labels (帽子) and abolishes or prohibits the use of personnel titles in human resource support, the association of personnel plan selection with salary and benefits, and the use of titles such as "project director" as honorary titles. Regarding evaluation, paper only, position only, and academic background only methods are abolished, and steps are taken to organize simple quantitative methods; accurately evaluate scientific, technical, economic, and social value; and exempt outstanding individuals from evaluation. For researchers tasked with outstanding core technology problem-solving missions (including invited researchers), monetary incentives will be expanded by introducing an annual stipend, which will be recorded as an increase in the total performance-based pay of the host institution. In addition, a mechanism for industry-academia integrated research based on scientific and technological achievements will be developed, so that researchers from universities and other institutions will visit enterprises to concurrently work on the practical application of their achievements. In such cases, researchers will be further incentivized to acquire shares in the practical applications of their findings, and there will be no restrictions to the total shares acquired.

The third point is "Taking measures to strengthen the performance evaluation of scientific research projects." First, the emphasis of management and evaluation will be shifted from quantity and process to quality and results. For this purpose, target selection will be clarified, classified evaluation will be conducted as usual, and review will be required in accordance with predetermined targets. Especially in project planning, results indicators will be aligned with guidelines and reviewed for feasibility, verifiability, and viability. The review process at critical stages will be strengthened, and support will be withdrawn if there are difficulties in achieving targets. In addition, project performance will be assessed through classified evaluation. In particular, basic research and applied basic research will be evaluated based on their originality, scientific value, effectiveness in solving problems in economic and

105 One of the science and technology intermediary organizations and a science and technology management organization.

106 This is called "double random one public" review, and it involves a random sampling of laboratories and review subjects, and the release of review results.

social development and critical national security needs, effectiveness in product development, quality and level of scientific achievements in representative papers, and so on, using the appropriate evaluation methods for each stage of technology development. In addition, an overall performance evaluation will be conducted strictly based on the mission statement. This will be done by examining each of the results indicators according to the mission statement and the spirit of the contract and determining the level of achievement, with no manipulation of results. Quantitative limits will be set, and priority will be given to the evaluation of representative results. Fraudulent materials will be dealt with strictly. Finally, the application of performance evaluation results will be strengthened, and managers, host institutions, and specialized management agencies will refer to the results of evaluations in performance reviews. Researchers with outstanding evaluation results will be given priority for awards, incentives, and so on, and a distinction will be made between underachievement owing to scientific uncertainty and failure due to poor research conduct, to encourage bold innovation and punish misconduct. When determining promotions and revenues, host institutions should focus on performance results, and not simply on the number of projects won or the amount of expenses incurred.

The fourth point is “Strengthening the responsibility of each department.” This will involve, first, establishing an “exemption mechanism for free exploration and technological innovation activities” that will exempt organizations or researchers from liability if, after completing their duty of diligence and responsibility, they find it difficult to achieve their desired targets owing to errors in the selection of technology roadmaps. In addition, distinctions must be made between accidental negligence, criminal acts, carelessness, self-interest, and other violations. In addition, the management authority of universities, research institutes, and other organizations will be fully respected; personnel, financial, and other management methods will be improved based on reform demands; researchers’ workload will be reduced by strengthening service awareness; researchers will be given control over personnel, finances, and materials based on sufficient credit; and those who commit serious violations of credit requirements will be subjected to lifelong pursuit and joint supervision measures. Furthermore, the evaluation of universities, research institutes, and other corporations will focus on the implementation of the national science and technology system reform policy. Corporations that have implemented the policy well and have improved their performance will be given an advantage in project reviews, approval of total performance-based pay, establishment of national science and technology innovation bases, approval of graduate student recruitment indicators, and so on.

Finally, the fifth point is a model “green channel” reform project that will select a limited number of institutions with outstanding innovation capabilities and potential, a remarkable track record, and good credit standing to further strengthen support through the experimental projects described below (selected institutions will be referred to as “model institutions”). First, scientific research management will be reformed based on performance, credit, and competence. This will include the simplification of the budgeting process by requiring only a basic estimate explanation of certain direct costs and eliminating the need for detailed statements. Model institutions will be allowed to extract incentive expenses within 20% of their stable support expenses and to seek to develop incentive guidance mechanisms. The scope of use and other matters related to expenses may be determined voluntarily by the institution concerned. In addition, the percentage of indirect costs for basic research, etc., where the cost of consumable experimental materials is low, will be increased (e.g., up to 30% for costs up to CNY 5 million), and indirect costs will be allocated preferentially to research teams and researchers with outstanding innovation performance. A differentiated cost guarantee mechanism will be implemented for various types of scientific research, such as cutting-edge basic research and public interest research, and a guaranteed mechanism that harmonizes stable support based on job responsibilities and positions with support through competitive funding will be developed. At cutting-edge basic research institutions, in particular, stable support through recurring expenses will be strengthened, and the standard for personnel cost subsidies will be raised to ensure reasonable salaries and benefits, so that researchers can concentrate on basic research and work on it long-term. For professional achievements from projects commissioned by enterprises and other organizations, the contracting parties will be permitted to independently determine the attribution, use, and distribution of profits from the achievements. If there is no contractual arrangement, the host institution will decide independently and consider granting ownership and usage rights to the researcher, as long as the professional achievements made using central government funds do not affect the national interest, national security, etc. If a model organization does not make sufficient efforts to promote its model project or fails to achieve the desired targets, its status as a model organization will be revoked and its support will be terminated. Moreover, its experience and the methods that have proven effective will be summarized and disseminated throughout the country.

⑤ June 11, 2019, Central Office of the Communist Party of China and Central Office of the State Council,“Opinions on further promoting the spirit of scientists and enhancing work and study styles[107]”

This document deserves special mention because although it is not an opinion specifically targeting the promotion of basic research, it expresses a spirit, so to speak, that will inform future science, technology, and innovation policies as a whole. In short, it can be summed up by a line at the beginning of the Basic Principles, which states, “Adhere to the Party’s guidance, enhance political standing, strengthen political leadership, ensure that the Party’s guidance carries through the entire process of science and technology projects, and firmly build a common ideological foundation for the science and technology community.” This is enough to make us wonder if those involved in science and technology can think flexibly and freely when they are so “bound” by the Party’s guiding spirit. Some of the contents seems too elementary, in terms of morality, to be directed at scientists and researchers. While it feels somewhat awkward to read these passages, we will try to present some excerpts.

Mentions of the spirit to be promoted appear one after another: “Greatly promote the spirit of scientists for a new era,” “greatly promote the patriotic spirit of consideration for the homeland and service of the people,” “greatly promote the spirit of innovation that overcomes difficulties, aims high, and seeks to reach achievements before anyone else,” “greatly promote the spirit of practice that pursues truth and rigorously governs academia,” “greatly promote the spirit of devotion to research without concern for honor or fame,” “greatly promote the spirit of cooperation by pooling wisdom to break barriers and working together in unity,” and “greatly promote the spirit of nurturing people by sacrificing one’s own interests for the sake of others and the progress of future scholars.” The section on “basic research” encourages interaction “at the top level” and “on the world stage.” It states, “Those who engage in basic research should set their sights on the top level in the world and have the courage to interact with researchers in the same field on the world stage.” This creates a tendency to pursue cutting-edge research projects and shapes a culture in which researchers can simply cover the topics that are attracting the most attention. Even a large number of cited papers could simply mean that a department is covering cutting-edge topics, making it questionable whether it is actually producing “Zero to One” achievements as initially instructed.

107 中共中央办公厅 国务院办公厅印发《关于进一步弘扬科学家精神加强作风和学风建设的意见》 2019-06-11 18:31 来源：新华社

On this basis, the opinions call for various precautions. "Respecting democracy in academia" invites institutions not to condemn those who express constructive criticism, not to take a cliquish approach, and to encourage young scholars to boldly put forward their academic viewpoints and interact with academic authorities. "Strictly observing the minimum line of conduct in deliberations" prohibits various undesirable behaviors. This includes measures to "strictly prohibit the inclusion of achievements outside the project period or irrelevant achievements in compensation for project achievements," "oppose the mere mention of unproven academic contributors," and "prohibit supervisors and scientific research project directors from violating the legitimate rights and interests of students and team members in terms of attribution of achievements, ownership of intellectual property rights, etc." In addition, in the event of a violation, "the issue must be exposed and clarified, and the matter must be investigated and dealt with strictly and brought to light publicly, without concession or cover." "Opposing exaggeration, frivolity, and taking advantage of opportunities to improve one's position" mandates the following:

① Within one month after publishing a paper or other scientific research results, relevant experimental records, experimental data, and other original data materials must be submitted to the affiliated organization for centralized management and preservation.

② Scientific researchers participating in national science and technology plan projects (special projects, funds, etc.) must have sufficient time to devote to their research, and team leaders responsible for challenging missions for core technologies in key national fields must be dedicated to the challenging mission full time.

③ The number of national science and technology plan projects (special projects, funds, etc.) in which a scientific researcher is the principal investigator or main participant must not, in principle, exceed two projects at the same time, or one project if the director of a university or scientific research institution or the head of a company is the project leader at the same time.

④ In the event that a National Talent Program awardee or a person responsible for a major scientific research project changes their place of employment without permission during their tenure or project execution period, resulting in serious losses or adverse effects, they will be held responsible appropriately in accordance with the regulations.

⑤ Concurrent positions must be related to the research specialty of the individual, and the individual may not hold various concurrent positions or lend their name to others without substantive work.

⑥ Universities, scientific research institutions, and enterprises must strengthen academic control over their scientific researchers and develop verification tests and enhance confirmation and verification procedures for those who have published many papers, obtained many patents, or made other achievements within a short period of time.

⑦ Scientific researchers must obtain the consent of their institutions when publicizing groundbreaking scientific and technological achievements and significant scientific research progress, must not intentionally exaggerate the technological value and economic and social effects and benefits when disseminating and commercializing scientific and technological achievements, must not conceal technological risks, must undergo evaluation by scholars and users in the same field, and must be recognized by the market.

Some of these are, of course, common sense measures. However, being subject to investigation for publishing many papers or applying for many patents in a short period of time is certainly a limitation for researchers.

"Opposing 'inner circle' culture in scientific research" calls for breaking down sectarian tendencies, eliminating profit connections and contacts, preventing the influence of personal feelings on evaluation and review, and preventing the influence of "mediators," "contacts," or emotional and workplace interests at each stage of evaluation and to revoke participation or eligibility if such acts are discovered. In any case, the basic code of conduct is also laid out in this section.

Now, let us review measures regarding science and technology management systems. First, emphasis is placed on the reduction of "micro-management and direct interference." Then, there is a mention of reforms to "delegate power, streamline administration, and optimize government services," which were mentioned several times above. It refers to "streamlining administration, delegating authority, combining relaxation of restrictions and management, and optimizing services." It is also stated that "science and technology management institutions that are premised on credit and that uphold credit as the minimum requirement will be established" and that "leading science and technology personnel will be given greater authority to determine technology paths, control costs, and procure resources." This point is expected to be further expanded institutionally in the future and is considered to be an important opportunity to assign responsibility while reducing management, as well as granting discretion to researchers under certain conditions. In addition, "project formation and resource allocation methods will be optimized, and resource allocation methods including stable support, competitive application, and designated contractor commissioning will be established according to the characteristics of each scientific research activity, so that the number and scale of projects can be rationally managed and problems such as 'package contracts,' 'multiple complex funding sources,' and 'dispersion of tasks' can be prevented. Scientific policy-making and democratic policy-making mechanisms for major scientific research projects should be established and consolidated, and the direction of major innovations should be determined by seeking a variety of opinions from the science and technology and industry communities on the national strategy and critical needs of the country." These points need to be examined in more concrete terms. In other words, it is worth paying particular attention to whether any novelty will be brought into the resource allocation system and what the democratic policy-making mechanism will be. It is also stated that "for matters that concern national security, major public interests, or compelling interests of society or the general public, a thorough preliminary argument evaluation[108] should be conducted. Mechanisms for assigning responsibility according to level and rank should be established and improved, and government authorities should have the courage to hold scientific researchers accountable for the failure of their endeavors." This clarifies the evaluation and responsibility for project selection and stipulates joint responsibility with researchers. However, depending on the point of view, it may mean that the primary responsibility falls more heavily on the researchers who select the projects.

"Properly exerting the functions of evaluation and guidance" calls for optimizing scientific research project evaluation and review mechanisms; assigning tasks to the most appropriate entities and personnel; preventing the indiscriminate pursuit of rankings; drastically reducing awards; prohibiting evaluation based only on papers, titles, academic background, and awards received; and eliminating duplicate support for the same personnel.

"Significantly reducing the burden on scientific researchers" emphasizes the implementation of online application and information sharing, the reduction of paperwork and cost calculation, the avoidance of duplicate titles, and the limitation of the number of inspections. Specifically, it states that "in principle, on-site inspections shall not exceed one per project for each fiscal year. Agencies specialized in project management must strengthen contract management, strictly control the number, types, and frequency of application documents in accordance with the requirement that

108 This refers to the theoretical preparation of a project during the planning and study phases.

application documents be submitted only once and practically implement the examination and acceptance inspection of project achievements in strict accordance with the contract." The opinions also "strictly prohibit specialized agencies and project personnel from asking evaluation and review specialists to perform preferential evaluations and resolutely prevent various forms of 'enclosure hunting' behavior." Reducing the workload for such researchers is generally highly desirable. However, the "Safeguard measures" call for "strengthening organizational safeguards" by encouraging researchers to develop a scientific spirit that extends to their daily lives and to enhance their attitudes toward work and learning. This indicates a strong involvement of the state and organizations in the attitudes of individual researchers and may severely damage the atmosphere of somewhat free scientific research. Although these provisions are not directly related to the content of scientific research, this does not seem like an atmosphere in which researchers can freely conduct research without worrying about their organization's judgment over what issues they choose to address or how they proceed. The involvement of organizations will be further discussed in section 7.3.

The opinions also call on the media to systematically gather information and promote the spirit of scientists, national heroes, and national stalwarts[109]. They further call for the cultural and artistic world to be creative in its approach to publicity methods. This kind of theatrical treatment of achievements is not unheard of in Japan, Europe, and the U.S., as is the case with Nobel laureates. However, it is somewhat questionable for the government itself to take the initiative in encouraging such treatment.

⑥ August 2, 2021 "Guiding opinions on improving the evaluation mechanisms for scientific and technological achievements" (State Council [2021] No. 26)[110]

With regard to science and technology evaluation, measures to eliminate the "paper only" mentality have already been indicated and thoroughly implemented in 2020, as will be discussed in detail in section 4.2. These opinions are about evaluation mechanisms, which are centered on linking research results to practical application and industrialization and utilizing them for economic and social development.

These guiding opinions are difficult to understand. Deciphering their inner workings requires considerable study, and considerable effort is probably being expended on the ground to ensure their thorough implementation in each organization in China. Here, we will explain the main points as clearly as possible.

Basically, the opinions begin as always with "Basic Principles" and are structured as follows: subjects of evaluation; evaluators; methods of evaluation; plurality of values; importance of evaluation by users, market, and third parties; and evaluation cycle.

First, the Basic Principles include several elements. They call for respecting the laws of scientific and technological innovation, reforming the methods of evaluation, and understanding the progressive development of scientific research and the stages of achievements. This should promote the early realization of the value of scientific and technological achievements. In short, the stages of development of scientific research achievements should be divided and evaluated in detail, and their value should be discovered and implemented in a timely manner. Finally, the Basic Principles call for valuing the positive attitude of scientific and technological personnel; identifying high-quality achievements,

109 The JST Science Portal China has published a series of biographies of past Chinese scientists titled "Hayashi Yukihide's Chinese Science and Technology Heroes." Whether intentionally or not, publishing this content is tantamount to implementing the CPC Central Committee policy calling for the promotion of "Chinese national heroes."

110 国务院办公厅关于完善科技成果评价机制的指导意见国办发〔2021〕26号

creating a good innovation ecology; promoting the deep integration of innovation chains, industrial chains, and value chains; and building new development patterns. This can be interpreted as a call for researchers to be more proactive in activities that lead to the creation of industrial value.

Regarding subjects of evaluation, the axes will be “quality,” “performance,” and “contribution,” and evaluation will be the “baton” that leads to the next step, with emphasis on the level of transformation and application and the contribution to economic and social development.

Regarding evaluators, it is said that the relationship between contribution to the government and effect on the market will be properly handled, that the role of the market is essential for resource allocation, that third-party evaluation should be introduced, and that a multi-dimensional evaluation system should be established with the participation of many actors. This refers to promoting the appropriate development of third-party and market evaluations.

Regarding evaluation methods, it is said that achievements should have multi-dimensional value, that multi-level evaluations should be conducted, and that achievements should be standardized and normalized to solve problems such as focusing on a single indicator or only on quantitative indicators[111].

The multi-dimensional values in the evaluation of scientific and technological achievements include scientific, technological, economic, social, and cultural values. Scientific value is evaluated with a focus on originality in terms of new discoveries, new principles, and new methods; technological value is evaluated in terms of contribution to industry and technological innovation; economic value is evaluated in terms of important impact on industrial development; social value is evaluated in terms of contribution to solving major problems such as health, national defense, and ecological environment; cultural value is evaluated in terms of promotion of the spirit of scientists, creation of innovative culture, and contribution to the promotion of the innovative values of socialism. There are no particularly novel values.

To improve the sound classification and evaluation of achievements, the evaluation of basic research will be based primarily on peer review, international “small peer” review[112] will be encouraged, a representative work system will be promoted, and quantitative and qualitative evaluation will be combined[113]. The achievements of applied research will be mainly evaluated by industry users and society, with the production of high-quality intellectual property

111 “In the evaluation of scientific and technological achievements, we need to return to the value itself, appropriately handle the relationship between the form and essence of achievements, make the value of scientific and technological achievements the core of evaluation, adhere to the simultaneous pursuit of ‘breaking the four onlys’ (only papers, only titles, only academic background, only awards) and ‘creating new standards,’ and subdividing the evaluation criteria to focus on ‘five essential values’ (values in the five areas of science, technology, economy, society, and culture) according to the various characteristics and evaluation objectives of scientific and technological achievements, evaluating the value of scientific and technological achievements in a directed manner.” (“Improving Evaluation Mechanisms for Science and Technology Achievements: Correctly Recognizing the Four Key Points,” Cheng Yanlin and Dai Tao [Institutes of Science and Development, Chinese Academy of Sciences], November 22, 2021, Science and Technology Topic No. 182, JST Science Portal China, https://spc.jst.go.jp/hottopics/2112/r2112_cheng.html, accessed December 26, 2021)

112 As of December 2021, there is no information regarding how foreign experts will be included in this “international” small business evaluation.

113 “Peer review has drawbacks including personal feelings and subjective speculation due to human relations, quantitative evaluation has the problems of emphasizing quantity over quality and ‘consolidated or split evaluation,’ and the problem of research misconduct exists as well. Due to the complexity, specialization, and gradual nature of scientific and technological achievements, as well as the time lag and unpredictability of their impact, the evaluation of scientific and technological achievements remains a global challenge, requiring constant improvement through theoretical and methodological research and practical exploration. Therefore, considering multidimensional values and various forms of scientific and technological achievements, it is necessary to strengthen theoretical and methodological research in the evaluation of scientific and technological achievements and develop new evaluation methods by using technological means such as big data and artificial intelligence” (*ibid.*)

rights and prototype performance of new technologies, materials, products, and so on, as the main indicators. Achievements in the development and industrialization of sensitive technologies, such as national defense and military technologies, will be mainly evaluated through user evaluation, market inspection, and third-party evaluation, with the value of technology transaction contracts, market valuation, and market share as indicators. For major achievements, retrospective and stepwise evaluation mechanisms of the R&D process will be explored to evaluate the enhanced truthfulness and credibility of the achievements. The opinions also call for the standardization of "third-party evaluation," and state that academic societies, research groups, and professional evaluation institutions should all play a role, self-management should be strengthened, conflict of interest avoidance systems should be improved, and the development of market evaluation activity standards should be promoted. To this end, common criteria for the evaluation of scientific and technological achievements will be established, and technical criteria and norms for evaluation in specific fields will be refined. Finally, in line with the reform of the evaluation of scientific and technological achievements, reviewing organizations will be adjusted, emphasis will be placed on encouraging researchers who have made creative contributions while adhering to integrity and honor, and a science and technology reward system, including the State Science and Technology Award, will be established without narrowly defined obstacles such as personal feelings, relationships, and interests.

Notably, the small-scale peer evaluation method of "small peer review[114]" is strongly recommended, as further emphasized in a paper by Xue Shu, Zhang Wenxia, and He Guangxi dated November 13, 2021. In the past, a common review method was having dozens of experts participate in a meeting and vote. However, it was generally concluded that having experts speak one at a time led to prolonged meetings where not many useful comments were obtained and opinions were not organized, which was ultimately not beneficial. The tendency is now to avoid meaningless multi-person reviews, and recently, small reviews are conducted by two or three experts. Incidentally, this is what is now required in any industry, as it is recommended to pursue high quality by specializing in one area rather than doing a bit of everything, focusing on small over large[115]. According to Professor Jiang Minghu of Tsinghua University, "the principles of small peer review are to go through a third-party evaluation and review mechanism, to be evaluated by experts, and to conduct scientific, fair, open, and equal competition." Its purpose is "to make departmental evaluation conducted by the Ministry of Education more accurate, to create more competitive departments, to complete major projects, to rapidly develop high-level human resources, and to improve the overall level of the university, with the advantage that small peer review can objectively evaluate potential for development[116]." Xu Xing, a member of the Chinese People's Political Consultative Conference and a paleontologist at the Academy of Sciences, argues, "Since small peer review is conducted by those who know the most about the work, ability, and value of researchers, it is not dependent on position, number of papers, impact factor, and so on. Instead, the content and presentation of papers alone are evaluated qualitatively and relatively accurately[117]." At the same time, Xu Xing notes, "'Small peer review' is generally qualitative, which can sometimes cause problems because of the risk of giving higher evaluations to

114 Here, "small" can mean small in number of people, but it can also mean "fine" (high) in quality.

115 The policy of "specialization, detail, character, and novelty" is a recent government initiative for small and medium-sized enterprises, but it is also being applied to science and technology enterprises. Specialization: strong expertise; precision: precise, detailed management or design; character: products or services with regional characteristics or special features; novelty: innovation, innovative products or technology.

116 Source: 破除"四唯"后该如何评价人才？ 委员建议"重视小同行评审",
https://www.sohu.com/a/299789094_773043 (accessed December 27, 2021)

117 *Ibid.*

individuals with connections. Another issue is that it may not be appropriate for different fields to compete for funds in the first place.” In other words, it is not appropriate to place research that accumulates data over a long period of time and cutting-edge research that discovers new principles in the same evaluation arena.

Judging from the perception of researchers, “small peer review” is seen as an evaluation conducted by a small number of experts who are extremely specialized with regard to the researchers and research topics to be evaluated. Small peer review may be considered a fair review process based on scientific merit, as well as a means to prevent favoritism and misconduct. However, the importance of the opportunity for this review to serve as a driving force to open up the frontiers of science does not necessarily appear to be accurately understood and acted upon. This point will be discussed further at the end of this section.

⑦ August 13, 2021, “Opinions of the Central Office of the State Council on the reform and improvement of fund management for scientific research funded by the central government[118]”

The major reforms and improvements in these opinions were proposed by Premier Li Keqiang during a discussion on the pig farming industry at the State Council Standing Committee meeting on July 28 of the same year. The aim was to give researchers more autonomy in managing research funds.

The major reform and improvement perspectives included increasing autonomy over the management of research funds, improving mechanisms for research funds, increasing incentives for researchers, reducing the administrative burden on researchers, innovating methods of funding and supporting research, and making research performance management mechanisms sounder. The following is a summary of the main reforms and improvements, which include some overlap with previous opinions, but are more specific in some respects.

Regarding the expansion of autonomy over the management of research funds, the first measure is the simplification of the budgeting process. The main simplification is to consolidate direct costs from nine budget items to three budget items (equipment, operations, and labor). Except for equipment costs of CNY 500,000 or more, explanations can be omitted from cost estimations, and cost estimations are not required to be granular. In addition, the review process for budgets is integrated, with an emphasis on “fitness for purpose,” “consistency with policy,” and “economic rationality.” The second measure is the delegation of budget adjustment authority. Previously, the budget was prepared by a specialized management organization for research funds[119], applied for, and approved by the Ministry of Science and Technology and then by the Ministry of Finance. Under these opinions, however, the authority to adjust the budget for equipment costs is delegated to the project host institution, and the authority to adjust the budget for operations and labor costs is delegated to the principal investigator. The third measure is the relaxation of restrictions concerning the use of research funds. The system for basic research and human resource projects should be as flexible as possible, with no restrictions on the percentage of expenses or use of research funds, in order to increase the flexibility and autonomy of researchers. This is called the “lump-sum system” (*bao gan ji*). In a project using the lump-sum system,

118 国务院办公厅「国务院办公厅关于改革完善中央财政科研经费管理的若干意见（国办发〔2021〕32号，http://www.gov.cn/zhengce/content/2021-08/13/content_5631102.htm (accessed December 10, 2021). The contents introduced here are quoted from “Pekin Tayori” [21-052] “Research Funds Management” Reform of the Management System on Central Fiscal Science and Technology Research Funds (JST Beijing Office, October 7, 2021).

119 A specialized management organization for research funds is a so-called intermediary organization that provides services for the management of research funds to host institutions.

the principal investigator is free to decide on the use of research funds on the condition of compliance with research ethics and research integrity. It is recommended that implementation of the lump-sum system begin from research institutions engaged in basic and frontier research, among others.

Regarding the improvements of mechanisms for research funds, the first measure is the rational determination of the funding plan. The project management department can formulate funding plans rationally and allocate research funds as appropriate based on the characteristics, progress, and funding needs of each project; it should respect the opinions of principal investigators and effectively respond their research needs when funds are first allocated. The second measure is the earlier disbursement of research funds. The finance department and the project management department can disburse research funds before the departmental budget is approved, and the project management department must pay the research funds to the project lead organization within 30 days of signing the project assignment letter. The project lead organization will pay research funds to the institutions participating in the project as appropriate, based on the input of the project leaders. The third measure is the possibility for the project implementing organization to use surplus funds directly for scientific research, rather than returning them to the government, after passing the performance evaluation on the management of surplus funds (previously, the funds could be used for subsequent research at the discretion of the project implementing organization for two years after the research was completed).

Regarding the expansion of incentives for researchers, the first measure is an increase in the percentage of indirect costs. After the revision, indirect costs will be calculated at a rate of 30% for CNY 5 million or less (20% for national key R&D before the revision), 25% for CNY 5 million to 10 million (15% before the revision), and 20% for CNY 10 million or more (13% before the revision), in relation to direct costs minus equipment costs. For purely theoretical basic research such as mathematics, the maximum limit for indirect costs is set at 60%. The second measure is the expansion of incentive grants, which extends the scope of a trial program offering up to 20% of scientific research grants as incentives to all central-level research institutions, leaving the scope and criteria for expenditures to the independent discretion of the research institutions themselves. The third measure is the expansion of the scope of labor cost payments, so that the employer's share of social security subsidies and housing reserves for those employed using research funds can be included in labor costs. The fourth measure concerns personnel costs and allows institutions to reasonably determine total performance salaries and only report to the Ministry of Human Resources and Social Security and the Ministry of Finance. Finally, remuneration for technology transfer of research achievements will not be included in the maximum total performance-based compensation for the institution and will not be used as a base number for verifying performance-based pay in the following year.

As for the reduction of the administrative burden on researchers, the first measure is the assignment of financial assistants to scientific research projects to provide specialized services such as budgeting and reimbursement and the possibility to cover related labor costs with project funds. The second measure is the improvement of advance payment of travel expenses for invited guests, which enables fixed amount payment for domestic travel expenses and accommodation expenses for which invoices are difficult to obtain. The third measure is a shift toward the digitization of receipts and other expense reports and toward a paperless system. The fourth measure is the simplification of acceptance inspections, integrating and simplifying project acceptance and financial acceptance inspections to conduct a comprehensive performance evaluation only once at the end of the project. The fifth measure is the optimization of procurement of research equipment and facilities. The need to bid for research equipment and facilities is eliminated, and applications to the Ministry of Finance for a change in the method of government procurement in accordance with laws and regulations are handled using a timed settlement system so that, in principle, applications that meet requirements are completed within five working days. In addition, expenses related to international cooperation and exchange of researchers are no longer included in the so-called “three public expenses[120]” fund and will not be restricted by requests to expand the scope of the zero tolerance policy for the “three public expenses.”

The next are measures to reform the way research is funded and supported. The first of these is the expansion of research funding channels to attract private capital for scientific and technological innovation, as well as to optimize the use of public research funds, promote the transfer and application of better scientific and technological results, and encourage a good mutual relationship between basic and applied research. The second measure is the promotion of pilot projects to support top-level researchers. The program will focus on major national strategies and frontier research areas, select world-class researchers, and provide them with stable and sustainable research funding. The researchers will select their own research projects within the priority areas, organize their research teams, and supervise the use of research funds. After three to five years, a third-party evaluation or an international peer review will be conducted. The third measure is to implement a “budget + negative list[121]” management model, which encourages local governments to adopt an internationally compliant governance structure and market-oriented operational mechanism for new R&D institutions[122] under the leadership of a board of directors and to implement a system of responsibility of the heads of research institutions. The “budget + negative list” management model will be encouraged to increase autonomy in the use of research funds and further allow scientific and technological achievements and intellectual property rights produced with the support of central government funds to be acquired by new research institutions in accordance with the law, allowing them to independently pursue applications and commercialization.

To implement a sound research performance management mechanism, the first measure is the further enhancement of project management departments’ performance orientation. These departments will shift from a process-oriented to a results-oriented approach, enhance their performance evaluation, and develop performance evaluation systems for various types of research projects, such as free exploration and task-oriented research projects, and resources will be allocated to the best talents and teams to improve the efficiency of research funds. The second measure is the enhancement of the supervision and inspection of research funds. Supervision and inspection methods will be improved; spot checks, inspection data sharing, and mutual recognition of inspection results will be promoted; and use of ICT technologies such as big data will be maximized to improve the efficiency of supervision and inspections. Research institutions will also manage the use of research funds in real time and dynamically monitor warning reminders to ensure the reasonable use and credibility of research funds. Individuals in charge of managing and using research funds will be held accountable and punished for serious misconduct, including through credit record management. The relevant negative lists will be prepared to clarify the scope of expenditures that are not permitted using research funds, and the relevant departments will inspect, review, and approve the research funds in accordance

120 Three public expenses: This term refers to expenses for entertainment, foreign travel, and purchase and operation of official vehicles paid for with public funds.

121 A system to list only items that should not be used. Original term: 负面清单

122 The Research Institute of Tsinghua University in Shenzhen was established in 1996 as the first of these new R&D institutions. The number of these institutions had increased to more than 1,000 nationwide as of 2017. They are managed under the leadership of a Board of Trustees and under the responsibility of a Director. They are certified at the local level, and support measures are in place for each region. Examples include the aforementioned Research Institute of Tsinghua University in Shenzhen; the National Institute of Biological Sciences, Beijing; the CAS Shenzhen Institutes of Advanced Technology; the Beijing Academy of Quantum Information Science; the Chinese Institute of Brain Science, Beijing; and the Beijing Academy of Artificial Intelligence.

with the law and the relevant negative lists, thereby relieving researchers of accountability.

The final step is organization and implementation. The first measure is the revision and improvement of regulations. Relevant departments and research institutions will focus on the "last mile" implementation of policies and reform measures related to research fund management and accelerate the revision of departmental regulations that are inconsistent with the spirit of the relevant documents of the CPC Central Committee. The second measure is the strengthening of policy promotion and training. Relevant departments will work to publicize policies on research fund management through various channels including websites and other media and, at the same time, provide special training for researchers, finance personnel, research finance assistants, and inspection personnel to continuously improve their work capacity. The third measure is the strengthening of guidance and supervision of policy implementation. Relevant departments will strengthen supervision of research institutions, and the State Council will strengthen supervisory checks. The fourth measure concerns the management of social science research project funds. The Ministry of Finance and central-level social science research project management departments will revise management methods for research funds related to central-level social science research projects based on the characteristics of social science research.

⑧ May 28, 2021, General Secretary Xi Jinping, "Speech at the 20th Congress of Academicians of the Chinese Academy of Sciences, the 15th Congress of Academicians of the Chinese Academy of Engineering, and the 10th National Congress of the Chinese Association for Science and Technology."

This speech was given after the basic direction of the 14th Five-Year Plan had already been presented at the People's Congress on March 5, 2021, but before the specifics of the science and technology innovation policy based on the plan were presented. Therefore, we would like to follow the basic policy transition here, focusing on the promotion of basic research.

As the title implies, the speech was delivered by President Xi Jinping on the occasion of a commemorative meeting of a group of scientific researchers. It is highly significant that Secretary General Xi himself directly addressed the researchers to express the policies he had introduced. In terms of content, there seems to be no significant difference from the abovementioned guiding opinions.

On this important occasion, Secretary General Xi emphasized that China's science and technology innovation policy has produced tremendous results, drawing on examples from various fields such as quantum information, stem cells, and brain science. He declared that "facts have proven that our country's independent innovation projects are promising." However, China faces a complex international environment, a sluggish global economy, and a global supply chain that needs to be rebuilt. In light of this, China is pursuing scientific and technological innovation on a fierce battleground, and competition over the high ground (commanding positions) of science and technology is more intense than ever. The speech then lists various issues and provides some directions.

First, it is stated that China will "strengthen its efforts to address the key issues of originality and leadership in science and technology and decisively win the battle for key technologies." The speech calls for the early formulation of a "ten-year action plan for basic research" on the grounds that "strengthening basic research is an inevitable requirement for the autonomy and self-reliance of science and technology." It further states that "basic research should be pursued bravely, and originality should be highlighted" and that "basic research should be more application-oriented, break through bottlenecks, identify scientific problems based on the actual problems facing economic and social development and national security, and understand the basic theory and technical principles of ‘life-or-death’ technology, and it therefore calls for strengthening financial investment in basic research.” This is followed by a reminder that “difficult breakthroughs in science and technology must adhere to a problem-solving orientation and move toward the most urgent and most pressing problems.” As mentioned above, this logical flow emphasizes so-called basic research while stressing the importance for this research to be application-oriented. This exerts pressure on researchers to include applications within the perspective of their basic research topics.

Second, the speech emphasizes “strengthening national strategic science and technology capabilities and improving the overall efficacy of the national innovation system.” It then identifies “national laboratories,” “national scientific research institutions,” “high-level research universities,” and “science and technology leading enterprises” as key components of national strategic science and technology capabilities and clarifies the missions that these elements fulfill. In this context, “high-level research universities” must demonstrate their superiority in “depth and profundity of basic research,” “become the main force for basic research and the new force for major breakthroughs in science and technology,” and “strengthen the connection between the construction of research universities and national strategic goals and issues and enhance the exploration of basic frontiers and breakthroughs in key core technologies.”

Third, the speech calls for a reform of science and technology institutions. The expressions used here seem to reflect the essence of Communist Party-led science and technology policy. In other words, by “ensuring the soundness of a new type of national system under the conditions of a socialist market economy” and “fully demonstrating the State’s role as an organizer of major scientific and technological innovations,” China will support difficult and promising strategic scientific projects; implement “systematic deployment,” “systematic organization,” and “cross-boundary integration“; and “bring together the forces of government, market, society, and other sectors to form an overall advantage.” Furthermore, China should “better combine effective market with effective government,” demonstrate the “decisive role of the market in resource allocation,” promote the “effective allocation of innovation resources according to market demand,” and form “a powerful combined force to promote innovation in science and technology.” In essence, this passage envisions a system in which the State or the Party connect innovation to issues that are effectively driven by market principles. Evaluation must also “accurately reflect the level of innovation of achievements, the actual contribution to economic and social development, and the actual results of conversion and application.” If the “improvement of classified evaluation systems for free exploratory and mission-oriented science and technology projects” is a step in the direction of allowing more freedom in the selection of so-called “free” proposals, this appears to be a departure from the past promotion of application-oriented basic research and future trends will be interesting to observe. In addition, the proposed “evaluation mechanism for non-consensus science and technology projects” is said to be based on “an awareness of the need to consider the method of prior evaluation of proposals in areas where there is no consensus, as had occurred when Professor Kishimoto, the chairman of the selection committee, was the only one to strongly push for the selection of Professor Yamanaka Shin’ya’s proposal”

(JST Beijing Office Director Chayama)[123] . In addition, as mentioned above, there is a need to establish evaluation indicators that are not limited to papers, titles, academic background, and awards (the above-mentioned "four only"), and the construction of a "scientific and technological human resource evaluation system guided by innovation value, ability, and contribution" is being promoted. It is also considered important to include groups of people engaged in "basic," "cutting-edge," and "public interest" research in the salary system of the national scientific research enterprise sector. Toward the end, the speech touches on the importance of reducing state involvement, which has already been pointed out, and advocates for "reducing direct involvement in money allocation, material allocation, project planning, and so on, strengthening guidance through policy planning, giving more autonomy to scientific research departments, giving scientists greater authority to determine technical paths and to spend money, and freeing the scientific research sector and scientific research personnel from the constraints of cumbersome and unnecessary institutional systems." In addition, "the project approval and organizational management methods for major science and technology projects should be reformed by implementing 'open recruitment to select project leaders who are motivated and capable' and 'a system that provides a fair competitive environment,' which must include appropriate open recruitment (true selection) and evaluation (selection with substance)." The above indicates a policy of developing evaluation methods that are not bound by formality but rather focus on substance, which is expected to be further specified in the 14th Five-Year Plan for Science and Technology Innovation.

Fourth, the speech calls for "building an open innovation ecosystem and participating in the management of global science and technology." In particular, it emphasizes the need to "actively integrate into the global innovation network" and "strengthen joint R&D with scientific researchers in other countries." Finally, it states that China will "establish scientific research funds on a global scale." At a time when the U.S. is maintaining a cautious stance toward cooperation with China and is seeking to take concrete measures in this regard, China's enthusiasm for the formation of such an international research network seems conspicuously one-sided. These "scientific research funds" would also have the power to bring together researchers from around the world in projects financed by China and could be the subject of controversy as a science and technology version of the Asian Infrastructure Investment Bank (AIIB). The response of major countries that will be approached for financial cooperation will be closely observed.

Fifth, China "ultimately needs high-level innovative talent to achieve a high level of science and technology independence and self-reliance" and therefore aims to "build a global talent high ground." In conclusion, the speech states that global competition is ultimately a "talent competition" and an "education competition" and that China should create an educational and social environment that establishes "ambitions for innovation." Finally, various moral terms such as service, patriotism, social responsibility, and devotion are mentioned as well. In addition, instructions for academicians include adhering to "academic morals," "setting the example for serious research," "breaking down the seniority-based system and the culture of nepotism," "contributing to the development of young people," and especially "reducing concurrent positions" and "focusing on specialized areas."

[123] In addition, according to ST20, "JST support for Professor Yamanaka's research dates back to four years before the publication of his groundbreaking research report on the generation of iPS cells from human skin cells. Professor Yamanaka's research was selected as a FY2003 project within CREST "Translational Research for Intractable Immune Disorders and Infectious Diseases," for which then Osaka University President Kishimoto Tadamitsu served as research director. Notably, Professor Kishimoto said in later years that, when he selected Professor Yamanaka's research, "I thought it would never work, but I selected it because I was impressed by the power of the interview." This is often cited as an example of the importance of having a "discerning eye" for finding researchers with high potential for future breakthroughs. https://www.jst.go.jp/20th/d-book/HTML/index32.html (accessed May 29, 2022)

(3) Other important guiding opinions

The above section introduced policy documents related to basic research promotion and scientific research management reform. In addition to the above, other recently issued government documents include the April 2021 "Notice on further promoting comprehensive innovation reform" (National Development Commission, Ministry of Science and Technology) and the 2021 "Explanation of science and technology policy at the Central Economic Work Conference."

The former emphasizes the steady implementation of the abovementioned reforms to "delegate power, streamline administration, and optimize government services," the granting of greater personnel autonomy, the promotion of "open competition" (*je ban gua swei*), "horse-racing" (*sai ma*), and engineer responsibility systems, as well as negative lists and tolerance for failure. It also introduces the policy of "planning and promoting a 'Xiaogang Village[124]' approach and overcoming problems and obstacles" and presents innovation activities as a true movement, retracing the history of the CPC.

The latter explanation announces the establishment and implementation of a three-year action plan for reforming the science and technology system and a ten-year plan for basic research, the reorganization of key laboratories nationwide, the implementation of R&D institution reform, the deepening of industry-academia-research collaboration, the improvement of science and technology innovation ecology, and the continuation of international science and technology cooperation. However, in terms of content, it does not include any particularly new measures.

2.6 Successive Reports on the Work of the Government under the Xi Jinping administration (through March 2022)

The only government plan that remains to be examined is the 14th Five-Year Plan for Science, Technology, and Innovation, which has been in effect since March 2021. However, we will now change perspective and summarize the statements made in the annual Reports on the Work of the Government (including some Reports of the Communist Party Congress) to evaluate the implementation of these plans. We will begin with a detailed look at the 14th Five-Year Plan for National Economic and Social Development.

Reports on the Work of the Government are usually submitted by the Premier at the National People's Congress held in March and are positioned as a summary of the year's activities up to that point and a confirmation of policies for the next year.

Below we have gathered excerpts and quotations from Reports on the Work of the Government issued since 2014, after the current Xi Jinping administration came into power, that relate to basic research promotion.

① "We will increase government spending on basic research and research on cutting-edge technologies, technologies for the public good and key standard technologies" (Report on the Work of the Government, 2nd Session of the 12th National People's Congress, March 5, 2014)

② "[We will] focus on supporting basic research, research in cutting-edge technologies, and key technologies that have a broad application," (Report on the Work of the Government, 3rd Session of the 12th National People's Congress, March 5, 2015)

124 The Chinese economic reform began in rural areas. One of them was Xiaogang Village, a village in Fengyang County, Anhui Province.

③ "We should strive to achieve major breakthroughs in basic research, applied research, and research in strategic and frontier fields by 2020." (Report on the Work of the Government, 3rd Session of the 12th National People's Congress, March 5, 2016)

④ "We will improve mechanisms for providing continued long-term support for fundamental research and original research" (Report on the Work of the Government, 5th Session of the 12th National People's Congress, March 5, 2017)

⑤ "We should (...) strengthen basic research and make major breakthroughs in pioneering basic research and groundbreaking and original innovations" (Report at the 19th National Congress of the Communist Party of China, October 18, 2017).

⑥ "We should strengthen basic research, application-oriented basic research, and original innovation and launch a number of major science and technology innovation programs" (Report on the Work of the Government, 1st Session of the 13th National People's Congress, March 5, 2018)

⑦ "We will provide stable support for basic research and application-oriented basic research, encourage enterprises to increase investment in R&D," and "introduce an open competition mechanism to select the best candidates to lead key research projects [and work toward technological breakthroughs][125]" (Report on the Work of the Government, Third Session of the 13th National People's Congress, May 22, 2020).

The 2019 Report on the Work of the Government does not include any relevant descriptions of basic research promotion in particular. However, it also states that scientific and "technological innovation is in essence a human creative activity" and allows a certain amount of discretionary authority for scientific research personnel while ensuring strict measures against misconduct, stating that the government will "take disciplinary action against academic misconduct, and guard firmly against rash action" with regard to ethics in scientific and technological research.

Below is a summary of the key points of Premier Li Keqiang's Report on the Work of the Government at the National People's Congress on March 5, 2021[126], and of the National Development and Reform Commission Report regarding science and technology.

The report[127], which expresses the latest guiding spirit, first describes the past year, 2020, as a year in which the focus was on rebuilding the economy after the turmoil and slowdown caused by the COVID-19 pandemic. However, among the major tasks for 2021, "Innovation" and "Pollution Prevention and Control and Ecological Conservation" are restored as independent items, and "Innovation" is promoted to the third position. Meanwhile, in "A review of Our Work in 2020," the difficulties and problems facing the economy and society are assessed as a lack of strong "innovation capacity in key areas." As for the major tasks for 2021, the "Main Targets and Tasks of the 14th Five-Year Plan Period" regarding the promotion of basic research are described as follows: "To improve China's innovation system, we will work faster to enhance our strategic scientific and technological capability underpinned by the development of national

125 The "open competition" approach that will be mentioned in the latter part of the report. It refers to "the open competition mechanism to select the best candidate to undertake key research projects."

126 Tanaka Osamu, Frontier Research Center, Institute of Developing Economies, JETRO, "Points of the 2021 Report on the Work of the Government (1)," https://www.ide.go.jp/Japanese/Researchers/tanaka_osamu/China_report/2021/ 20210316.html (accessed July 20, 2021)

127 Report on the Work of the Government, March 5, 2021, Fourth Session of the 13th National People's Congress, Premier of the State Council Li Keqiang, https://infact.press/wp-content/uploads/2021/03/%E7%AC%AC13%E6%9C%9F%E5%85%A8%E4%BA%BA %E4%BB%A3.pdf (accessed July 16, 2021)

laboratories, strive to make major breakthroughs in core technologies in key fields, and formulate and implement a 10-year action plan for basic research. We will enhance the capacity of enterprises to make technological innovation, unlock the creativity of talent, and improve the systems and mechanisms for making scientific and technological innovation. China's R&D spending will increase by more than 7 percent per year, which is expected to account for a higher percentage of GDP than that during the 13th Five-Year Plan period. Extensive activities will be conducted to help people learn more about science." In addition, the report's "Major Tasks for 2021" section states, "Basic research is the wellspring of scientific and technological innovation. So we will ensure the stable functioning of funding mechanisms for basic research and boost spending in this area by a considerable sum. Central government expenditure on basic research will increase by 10.6 percent. Research institutes will have more say about how funds should be used, and the mechanisms for project applications, assessments, fund management, and personnel evaluations and incentives will be refined. We will work hard to help researchers get rid of undue burdens and enable them to fully devote their time and energy to making scientific explorations and major breakthroughs in key technologies, just as a blacksmith in the past would spend years forging the perfect sword" (i.e., cultivating skills for a long period of time). First of all, the formulation of the 10-year action plan for basic research is awaited, and the question will be to what extent the spirit of "spending years forging the perfect sword" will be thoroughly implemented in project proposals, reviews, and evaluations in the field.

In sum, even though basic research has been promoted, what has been emphasized and invested in has always been basic research as a path to innovation. In July 2015, at a national science and technology strategy roundtable meeting, Premier Li Keqiang indicated the direction of science and technology research with the phrase "apex position," where "apex" refers to high-level research aimed at world-class technology, and "position" is said to mean the use of technology in line with market trends. He reportedly "called for balancing basic technology and applied research," demonstrating that the government's guiding ideology is still very application-oriented and application-focused, despite its emphasis on basic research[128].

Premier Li Keqiang, who has made "science and technology independence and self-reliance, strengthening of basic research, and development of the digital economy" the centerpieces of the next Five-Year Plan, said at a press conference on March 11, 2021, soon after the end of the National People's Congress, "Our R&D spending as a percentage of GDP is still modest, especially in terms of basic research. It only accounts for six percent of total R&D spending whereas the number in developed countries ranges between 15 to 25 percent. We will continue to increase input in basic research." Regarding science and technology independence and self-reliance, he said, "Yet it is also compatible with promoting international cooperation and exchanges among global scientists. Scientific explorations, discoveries, and inventions call for cooperation and joint efforts. Isolation will lead nowhere and severance of industrial or supply chains will do no one good. Based on protecting intellectual property, China is ready to enhance cooperation with all other countries in science and technology to jointly promote progress of human civilization." It should be noted that the Premier's report emphasizes increased investment in basic research.

In addition to the above, on March 5 of the same year, the National Development and Reform Commission submitted the Report on the Status of Execution of the National Economic and Social Development Plan for 2020 and

[128] Open Innovation Media, "Will China's Winning Strategy of 'Technology Will Follow' Work for Basic Technology?" https://media.dglab.com/2018/10/30-hard%EF%BC%86coretechnology-01/ (accessed May 31, 2021)

Draft National Economic and Social Development Plan for 2021 to the National People's Congress for consideration[129].

The report states, "We have taken a step forward in the level of science and technology by promoting in-depth efforts aimed at innovation-driven development. Innovation is at the core of China's overall modernization construction, and it will be continuously reinforced. The ratio of R&D expenditures to GDP reached 2.4%, and the contribution to the development of science and technology (...) was more than 60%." Then, the development status of scientific and technological innovation in various fields is described as part of the achievements of 2020. The specific fields will not be mentioned one by one here, but as usual, they include space and astronomy. Based on this, the main mission for 2021 is to "accelerate self-reliance and self-reinforcement in science and technology, raise the level of the industrial foundation, and promote the modernization of the industrial chain." Goals in individual areas are as follows: "continue to raise the level in national strategic science and technology, strengthen basic and applied research and commercialization of research results, and enhance the core competitiveness of Chinese industry." Although there are no particularly noteworthy statements about basic research, the following points are mentioned as ways to "significantly improve scientific and technological innovation capabilities": "Accelerate the construction of State Key Laboratories and reorganize the system of State Key Laboratories," "Establish a National Medium- and Long-Term Program for Science and Technology Development (2021-2035)," and "Accelerate scientific and technological innovation in artificial intelligence, quantum science, brain science, and so on."

Finally, in his Report on the Work of the Government at the National People's Congress held in March 2022, Premier Li Keqiang stated that 2021 was an important year for the start of the 14th Five-Year Plan and a meaningful year for the realization of the first of two centenary goals, that is, "building a moderately prosperous society," as well as the 100th anniversary of the founding of the Chinese Communist Party. He then reviewed the year's achievement, mentioning major advances in national strategic science and technology capabilities and key core technologies, especially Mars exploration and manned space flight, a 15.5% increase in corporate R&D expenditures, reforms to "delegate power, streamline administration, and optimize government services," and steady progress on construction for the Belt and Road Initiative. In addition, the report set out the following major operations to be conducted in 2022.

① Construct national laboratories and implement major science and technology projects.

② Improve the management of scientific research funds, increase the proportion of indirect costs, and expand the autonomy of scientific research.

③ Implement the R&D expense deduction system and increase the percentage of R&D expense deductions for small and medium-sized science and technology enterprises, such as those related to the manufacturing industry, to 100% (originally up to 75%).

④ Strengthen industry connections so that they can compensate for each other's weaknesses.

⑤ Accelerate the digitalization and reform of traditional industries and support the development of emerging industries.

⑥ Further strengthen the Belt and Road Initiative.

⑦ Ensure separation between industry associations and government agencies.

⑧ Reform state-owned enterprises over a period of three years.

129 "14th Five-Year Plan - National People's Congress" Report of the National Development and Reform Commission: Statement on Science and Technology, JST Beijing Office, March 9, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_016.html (accessed July 20, 2021)

⑨ Establish a ten-year plan for basic research and provide long-term, stable support for basic research.

⑩ Strengthen science and technology investment in rural areas to achieve distinctive local innovation.

⑪ Strengthen international science and technology collaboration and cooperation.

⑫ Construct global key talent centers and high-level innovation areas and improve human resource development mechanisms and institutions.

⑬ Strengthen support for young researchers and create an environment in which they can focus solely on their research.

⑭ Strengthen the role of State Key Laboratories and national laboratories, and further reform and improve the management of major science and technology projects in university laboratories.

⑮ Strengthen protection for intellectual property rights.

⑯ Further strengthen the status of enterprises as drivers of innovation and deepen collaboration between industry, academia, and research institutes.

⑰ Develop science and technology financial products and services and raise the service level of science and technology intermediary organizations.

⑱ Provide incentives to enterprises conducting basic research through support for equipment replacement, taxation, etc.

2.7 Outline of the 14th Five-Year Plan for National Economic and Social Development (2021-2025) and Long-Term Objectives through the Year 2035

The remarks on science and technology at the National People’s Congress on March 5, 2021[130], included the announcement of major tasks for 2021, which anticipated the basic direction of the upcoming 14th Five-Year Plan for Science and Technology Innovation. The direction was indicated as follows: “Basic research is the wellspring of scientific and technological innovation. So we will ensure the stable functioning of funding mechanisms for basic research and boost spending in this area by a considerable sum. Central government expenditure on basic research will increase by 10.6 percent. Research institutes will have more say about how funds should be used, and the mechanisms for project applications, assessments, fund management, and personnel evaluations and incentives will be refined. We will work hard to help researchers get rid of undue burdens and enable them to fully devote their time and energy to making scientific explorations and major breakthroughs in key technologies, just as a blacksmith in the past would spend years forging the perfect sword.” In addition, Minister of Science and Technology Wang Zhigang summarized the development results of scientific and technological innovation during the 13th Five-Year Plan on February 27, just prior to the National People’s Congress[131]. In his remarks, Minister Wang highlighted six “new” aspects, including “the systematic promotion of basic research and strategic pursuit of key core technologies, and the realization of a ‘new leap forward’ in science and technology innovation capability.” Regarding the 14th Five-Year Plan, he argued

130 “[21-015] ‘14th Five-Year Plan - National People’s Congress’ Science and Technology Innovation Statements in the 2021 Report on the Work of the Government”, Beijing Office, JST Pekin Tayori, March 8, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_015.html (accessed June 28, 2021)

131 This was stated by the head of the relevant department of the Ministry of Science and Technology at a press conference held at the State Council News Office on February 26, 2021. “China’s Basic Research Expenditures Nearly Doubled in the 13th Five-Year Plan Period,” People’s Daily Online Japanese Edition, February 27, 2021, http://j.people.com.cn/n3/2021/0227/c95952-9822876.html

that "the new strategic support role of science and technology must be fully demonstrated." However, basic research promotion was not specifically mentioned in these remarks. Dr. Ye Yujiang, the head of the ministry's Basic Research Department, also commented on the state of basic research. He explained, "(1) The department's development is in good condition and has made a series of significant original achievements. (2) The department's basic research budget has increased significantly. During the 13th Five-Year Plan period, China's basic research expenditures nearly doubled, and by 2020, they are expected to exceed CNY 150 billion (approximately JPY 2.468 trillion). (3) The policy system to support the development of basic research has continued to improve. (4) The construction of scientific research bases has made important progress[132]." At the very least, investment in basic research has been increasing annually at a rate of about 15% in recent years, so it is quite likely that it will reach CNY 150 billion by 2020. However, it is difficult to make a specific evaluation of the "policy system to support the development of basic research" because the exact meaning of that phrase in this context is unclear.

With this in mind, let us first examine the main points of the Outline of the 14th Five-Year Plan for National Economic and Social Development (2021-2025) and Long-Range Objectives through the Year 2035, released on March 12, 2021. The Long-Range Objectives through the Year 2035 have already been described in Section 2.3(4), although they are very limited in terms of quantity and quality as long-term objectives. The 14th Five-Year Plan itself will be introduced here.

This plan consists of 19 parts and 65 chapters. Scientific and technological innovation, which was discussed in Part VII of the 12th Five-Year Plan (albeit without using the term "innovation") and in Part II of the 13th Five-Year Plan, occupies Chapters 4 through 7 of Part II of the new plan[133].

In Part I, "Embarking on A New Journey to Build a Modern Socialist Country in All Respects," Section 1, "The Critical Achievements That Secured a Decisive Victory in Building a Moderately Prosperous Society" states, "The endeavor to build a country of innovators yielded substantial progress, with major advances in manned spaceflight, lunar exploration, deep-sea engineering, supercomputing, quantum information, the Fuxing high-speed train, and large aircraft manufacturing." However, ongoing problems are mentioned as well, with the harsh assessment that "innovation capacity remains below the level needed for high-quality development."

The "Guiding Principles" section in the same part of the plan states, "Taking the promotion of high-quality development as the theme, deepening supply-side structural reform as the main line, reform and innovation as the fundamental driving force, and meeting the ever-increasing needs of the people for a better life as the fundamental objective, we will create a unified development and security plan and accelerate the construction of a modern economic system." The "Strategic Direction" emphasizes "innovation-driven" development.

In the subsequent Long-Range Objectives through the Year 2035, among the Main Objectives, it is stated that "By 2035, our country will have basically realized socialist modernization. China will make significant strides in its economic, technological, and overall national strength; advance to a new stage in its overall economy and per capita income of urban and rural residents; achieve significant breakthroughs in key core technologies; and become one of the global leaders in innovation." Under "Objectives for Economic and Social Development in the 14th Five-Year Plan Period," it is stated that "if total labor productivity growth exceeds GDP growth, the domestic market will become

132 *Ibid.*

133 The structure of Chinese government documents uses consecutive numbers (running numbers) for both editions and chapters.

more powerful, the economic structure will be further optimized, and the capacity for innovation will be significantly enhanced. The average annual growth rate of R&D investment will be 7% or more for the entire society, investment intensity is expected to exceed the actual level of the 13th Five-Year Plan period, and the level of upgrading industrial infrastructure and modernization of industrial chains will be significantly enhanced." The plan sets the objectives of increasing the growth rate of R&D investment to 7% or more for the entire society, increase the number of patents for high-value inventions from 6.3 to 12 per 10,000 people, and increase the share of GDP in the core industries of the digital economy from 7.8% to 10%. No objective has yet been set for total R&D investment as a percentage of GDP, which was 2.5% in the 13th Five-Year Plan (as of the end of June 2021). This indicator was already at 2.4% in 2020. However, its future will depend on how the economy grows after the COVID-19 pandemic. According to China Money Network, in order to increase R&D investment, especially in enterprises, a 75% deduction will be provided for R&D investment by enterprises, the rate of additional deduction for manufacturing will be increased to 100%, and tax incentives will be provided to further encourage R&D investment[134]. In the article, Ren Zhengfei, the founder of Huawei, notes the importance of Chinese investment in basic education and basic research, especially after strict measures were imposed on Huawei by the U.S. In speeches at Peking University, Tsinghua University, and other universities, Ren said, "Chinese enterprises overall are extremely large. If the core values that support them are not strong enough, what will happen when a typhoon comes? Development activities that seek immediate results are unstable."

Scientific and technological innovation is addressed in Part II of the plan, "Adhering to Innovation-Driven Development and Comprehensively Creating New Strengths in Development." This section advocates for the strengthening of scientific and technological capabilities in national strategies, the harmonization and optimization of scientific and technological resource allocation, and the enhancement of original and leading scientific and technological strategies. It raises various topics to be addressed, such as next-generation artificial intelligence, quantum information, integrated circuits, and biotechnology.

Basic research, which is the subject of this report, is addressed in the first chapter of Part II, Chapter 4, "Strengthening Science and Technology Capabilities in the National Strategy," which includes sections on "Aligning and optimizing science and technology resource allocation," "Strengthening original and leading science and technology strategies," and "Building a major science and technology innovation platform." Section 3 of this chapter, which is entitled "Persistent strengthening of basic research," is quoted below in its entirety.

"We will strengthen leadership through applied research and encourage free exploration. We will formulate and implement a 10-year action plan for basic research and focus on a group of basic scientific research centers. We will strengthen fiscal investment in basic research, optimize the spending structure, and provide tax incentives for investment in basic research by enterprises. We will encourage investment by society through multiple channels, such as donations and the establishment of foundations, to create sustainable and stable investment mechanisms. We will raise the proportion of R&D expenditure and investment in basic research to at least 8% of total R&D expenditure and investment. We will create and improve evaluation and incentive systems that conform to scientific laws, provide long-term evaluation for basic research exploration, and create a favorable scientific research ecosystem that is conducive to

[134] China Money Network, "China's 14th Five-Year Plan Aims To Increase R&D Spending, Tax Credit To Spur Basic Research," March 9, 2021, https://www.chinamoneynetwork.com/2021/03/09/chinas-14th-five-year-plan-aims-to-increase-rd-spending-tax-credit-to-spur-basic-research (accessed June 21, 2021)

basic research.”

Interestingly, while the phrase “encourage free exploration” is used, it is preceded, as always, by “strengthening leadership through applied research.” Further, the “ten-year action plan for basic research” has yet to be created as of the end of May 2022. In addition, “investment in basic research by enterprises,” including the use of government procurement and tax credit for R&D investment by high-tech enterprises, is being promoted more strongly than in the past. “Donations and the establishment of foundations” are also encouraged, although the feasibility and extent of this is unclear. This measure may indicate the intention to strengthen the promotion of science through British-style endowments in a situation where so-called social organizations are becoming financially stronger. The most significant aspect is the first-ever target set for basic research investment, which is to increase the share of investment in basic research to at least 8% of total R&D investment. The share of investment in basic research, which has hovered between 5% and 6% for a long time, has been on the rise in recent years. Needless to say, it is significant that a target is finally being set here (see section 3.1 for more information on financial investment in basic research). In addition, the plan aims to create a favorable scientific research ecosystem that is conducive to basic research, which is quite commendable in terms of direction. However, the content and methods of this specific measure raise questions. The section entitled “Building a major science and technology innovation platform” in this chapter calls for the construction of a “high-end exchange platform for national scientific research papers and scientific and technological information.” This is a serious attempt on the part of China to gain institutional power[135] different from that of the West in the area of scientific journals, and the formulation of specific measures in this regard is noteworthy.

Next, Chapter 5, “Enhancing the Technological Innovation Capability of Enterprises,” includes sections on “Encouraging greater R&D investment by enterprises,” “Supporting R&D in fundamental technologies common to multiple industries,” and “Improving innovation systems for enterprises.” Notable measures in this chapter are the industry-led development of “basic technology platforms“; the construction of “national industrial innovation centers” in collaboration with higher education institutions, scientific research institutions, and enterprises; the “transformation of scientific research institutions”; the provision of “basic technology services of public interest”; and the “establishment of mixed-ownership industrial technology research institutions based on industrial clusters.” Here, we see a move to integrate universities and national research institutions with industry and to make national research institutions function for industry.

Next, Chapter 6, “Stimulating the Vitality of Talent Innovation,” is also very relevant to the promotion of basic research. In particular, we would like to emphasize that Section 1 of this chapter includes the following proposals: “Establishing innovative postdoctoral positions,” “Strengthening the training of outstanding students in basic sciences,” “Creating basic department bases and advanced science centers in mathematics, physics, chemistry, and biology,” “establishing a permanent residence system for foreign high-end talent and a technical immigration system,” and “Providing international competitiveness and attractiveness for foreign scientists to work in China through the improvement of systems such as remuneration, welfare, child education, and social security.” Section 2 proposes the following human resource evaluation and incentive systems: “developing an evaluation system oriented toward innovation capabilities, actual effectiveness, and contribution,” “establishing a profit distribution system that embodies the value of innovative elements,” “selecting and using leadership talents and granting them greater rights

135 This refers to so-called “structural power” or “institutional discourse power.”

to determine technology roadmaps and use funds," "simplifying scientific research management," "implementing distribution policies based on increased intellectual value," and "developing a system for researchers to benefit from the results of their inventions and increasing their share of profits from the ownership of achievements." In particular, granting researchers "greater authority to determine technology roadmaps and use of funds" is extremely important for the management of research sites. The specific methods used to accomplish this will be closely observed. In Section 3, "Optimizing the ecosystem of innovation, entrepreneurship, and creation," a novel approach is that of "advocating an innovative and entrepreneurial culture of hard work, study, dedication, and tolerance for failure, and to improve the system of trial and error, recovery from failure, and correction." In particular, it will be of great interest to see how "tolerance for failure" will be realized within the framework of the Communist Party's leadership.

Chapter 7, "Improvement of the Science and Technology Innovation System," is also closely related to the promotion of basic research and includes sections on "Deepening science and technology management systems," "Improving the system for the protection and operation of intellectual property rights," and "Actively promoting open cooperation in science and technology." We will supplement these key points and analyze their distinctive features from the perspective of basic research promotion. In short, these measures constitute a "reform of science and technology systems."

Section 1, "Deepening the reform of science and technology management systems," calls for accelerating the transformation of management functions and taking the lead in policy, while "reducing direct involvement in the provision of funds and supplies, project decisions, etc." In addition to "focusing investment in areas of strategic importance," "modifying the decentralized status of departments," and "granting more autonomy to scientific research units and researchers," the plan calls for "adopting a system of chief technology officers" and "an open application system," and "improving funding support systems that integrate incentives and grants." Measures concerning evaluation systems include "improving free exploration and mission-oriented classified evaluation systems," "improving the evaluation system for non-consensus[136] science and technology projects," "optimizing incentive projects," and "establishing a modern institute system" by "experimenting with flexible project unit organization, positions, salaries, and other management systems." The plan also advocates for the "establishment of a system of free and orderly flow of innovation resources among universities, research institutes, and enterprises." Section 2 contains measures related to the operation of intellectual property rights protection. The plan calls for "accelerating intellectual property rights legislation to implement a strict intellectual property rights protection system," "fostering patent-intensive industries by protecting and encouraging high-value patents," and "expanding the autonomy of universities and other institutions to dispose of intellectual property rights by reviewing rights allocation relationships." Section 3 concerns the promotion of open cooperation. This section reflects China's vision for the post-COVID era and the kind of international cooperation China is aiming for amid the global situation shaped by the U.S.-China conflict. The goal is to "implement an open, tolerant, mutually beneficial and shared international cooperation strategy" and "more actively integrate into the global innovation network." The plan advocates for "pragmatically promoting infectious disease control and other measures and strengthening joint research on climate change and health issues," "proactively designing and leading major scientific programs and projects, and supporting the unique role of advocacy

136 The term "non-consensus" here refers to projects that do not pass the review process as a result of disagreement among the reviewers on the content of the review in the process of evaluation. These are also referred to as "conflicting reviews."

and science funds," "strengthening the external opening of national science and technology programs," "considering the establishment of a global scientific research fund and the implementation of scientist exchange programs," and "supporting the establishment of international science and technology organizations within the country and the recruitment of foreign researchers." Note that much of this part of the plan had already been introduced based on the proposals discussed at the fifth plenary session of October 2020.

2.8 The 14th Five-Year Plan for National Science and Technology Innovation (2021-2025)

The 14th Five-Year Plan for National Economic and Social Development (2021-2025) sets forth the basic direction of reform, and the successive Guiding Opinions already mentioned above provide specific details that go considerably further and are in the process of being implemented one by one. As of the end of May 2022, the five-year plan has yet to be formulated. Although some measures are expected to be presented in more detail, it is anticipated that friction with the U.S. over emerging and key technologies will become more serious, and that work will be conducted with particular caution, especially in the areas of international cooperation and international personnel exchange. According to one theory, "The anticipated prolonged competition with the U.S. and the hasty formulation and publication of plans in the field of science and technology may lead the U.S. and other Western countries to enact science and technology countermeasures. This is one of the reasons why some experts have suggested postponing or, as far as possible, not publishing the plans[137]"

2.9 Other major reforms initiated by non-governmental organizations

In China, once the CPC Central Committee, the State Council, and other government agencies have issued their basic policies, local governments at all levels follow those policies to define and apply specific measures and implementation plans in a fairly autonomous manner. This can be seen as a force that generates flexible and dynamic on-field activities nationwide, even if these activities sometimes deviate from the stated principles. Although there are many different examples, here, we will focus on major reforms by CAS and the city of Shanghai.

On November 5, 2021, CAS enacted the "Opinions of the Chinese Academy of Sciences on strengthening basic research" (commonly known as the "Ten Articles of Basic Research").

Before the release of the 14th Five-Year National Science and Technology Innovation Plan, which is to be formulated by the central government, several organizations have formulated and released their own specific policies for the promotion of basic research. CAS, which is in a leadership position among them, issued the abovementioned opinions on November 5, 2021, and is guiding policies to promote basic research.

First, regarding the positioning of basic research, the opinions state that the main task of basic research is to identify the direction of "national strategic demands and critical issues at the forefront of science" and that national development will guide basic research. Specifically, the direction of CAS work will be determined, focused research

137 JST/APRC, "Survey on Mechanisms for Identifying and Promoting Excellence in China's R&D System," Report of Survey Commissioned to Tepia Corporation Japan, https://spap.jst.go.jp/investigation/downloads/2021_br_01.pdf (accessed July 2, 2022)

fields will be narrowed down, and research will be systematically developed based on the requirements of national development for basic research. Moreover, CAS will “fully utilize its strengths, such as having a comprehensive platform and the ability to conduct multidisciplinary research and also maintain regular high-level free exploratory research.” Although free exploratory research is mentioned, it is still strongly positioned as driven by national strategic demands.

In terms of research fields, CAS will lead basic research on cutting-edge technologies, provide a source for breakthroughs in transformative technologies, support the development of emerging industries, and prepare for the development of new industries and fields, while developing basic research departments and interdisciplinary departments. Again, the contribution to industrial technology is strongly emphasized, and academic development is pushed into the background.

The reform of CAS is supposed to establish an internationally influential basic research base and to strengthen the autonomy of CAS by establishing new international-level basic departmental research centers in disciplines such as mathematics, physics, and chemistry.

In terms of the selection of topics, it is said that the direction will change from what researchers “want to do” or “are doing” to what they “should do” and that the direction to be pursued will be clarified by quickly identifying key science and technology issues and difficult problems based on national strategic demands. CAS will also collaborate with various in-demand industry sectors and enterprises to discuss and solve critical scientific issues in social development. In any case, basic research is expected to contribute to issues of national importance.

The need to reform the way CAS is managed as a scientific research institution is reiterated, including the creation of core teams to accomplish important scientific and technological missions, the management of research teams with fluidity and flexibility, the establishment of laboratories for priority areas, the exercise of autonomy by researchers in team composition and resource allocation, the creation of a system in which the chief scientist is responsible for the project, the implementation of a “lump-sum system” for funds, the creation of new departments, and the promotion of shared platforms and use of resources.

Regarding the use of facilities, basic research bases will be established in cooperation with major national science and technology infrastructure facilities to research key issues and create science and technology infrastructure facilities that can lead other institutions.

Basic research posts will be created to foster high-level basic research personnel, promoting human resource development with a focus on young scientists. In addition, a basic research young team program will be implemented to support research in a relaxed environment. In the development of young human resources, the program will select outstanding young leaders regardless of their background and will actively select leaders under the age of 45 years to form postdoctoral teams.

Finally, the evaluation system will be reformed by eliminating the “four only” standard and making quality, competence, and performance, as well as contribution to addressing difficult problems, the evaluation criteria. Achievements will be evaluated on the basis of scientific significance and applied value and on the basis of originality and high contribution; human resources will be evaluated on innovation potential and actual academic contribution; and institutions will be evaluated based on how well they have adjusted their scientific research layout and enhanced their talent and academic environment to produce achievements. For peer evaluation, a longer cycle will be used, and a representative work mechanism will be promoted to make the system more tolerant of failure. Basic research driven by national strategic demands will be evaluated in terms of potential and applied value, specifically the extent to which it can contribute to breaking through technology bottlenecks, combining the evaluations of the relevant industry and the demand side[138].

Finally, CAS will organize international science programs, increase China's influence and contribution, strengthen international collaboration through participation in global science and technology networks, and create a favorable atmosphere for science and technology by maintaining the traditional spirit of scientists; working diligently on research; not overlooking research misconduct; combining academic interests with national demands; and combining professionalism with patriotic contributions.

Overall, the situation is far from one in which free exploratory research and free choice of subject matter are allowed. In fact, priority is given to meeting important national demands, and as demonstrated by the passage "combining academic interests with national demands" at the end, the prevailing atmosphere is one in which research cannot be based solely on academic interests. This is certainly not an environment where researchers can freely expand their own scientific interests. This is the interpretation of CAS as the top organization leading the implementation unit in the field and differs from the documents of the CPC Central Committee and the State Council. The fact of the matter, however, is that once this interpretation is made, researchers will follow its guidance.

In his keynote speech at the 19th Conference on International Exchange of Professionals in April 2021, Minister of Science and Technology Wang Zhigang, reportedly said, "China has consistently strived to invite and train high-level talent with a global perspective, providing an ideal habitat for talent working on innovation and start-ups around the world[139]." However, it is time to consider how this talent has been received.

Important information can also be found in the human resource priorities set by CAS Vice President Zhang Tao at the "Conference on Accelerating the Construction of the Shanghai Science and Technology Innovation Center with Global Impact."

On September 29, 2021, when the 14th Five-Year Plan for National Science and Technology Innovation had not yet been released, CAS President Zhang announced the institution's policy on the following matters, which may be considered a precursor to the contents of the plan[140]. The main contents of the policy are outlined below.

The first measure is to strengthen the Shanghai Science and Technology Innovation Center's ability to attract and retain outstanding human resources. China needs to acquire high-level talent from a global perspective, not only domestic talent. To that end, the country will strengthen the "Hundred Talents Program" brand that it has maintained for many years, focus on basic frontier primitive innovation and key core technology research, attract talent with high standards and precision according to needs, and particularly increase the introduction of young top-level and urgently needed key personnel.

The second measure is to strategically deploy key scientific research and strengthen the development of top-level human resources in science and technology. China needs to develop world-class science and technology talent. To that

[138] According to the results of a survey commissioned by Japan TEPIA Corporation, which introduced the opinions of Zhu Hongyong (Vice President of the China Institute of Atomic Energy) on the prospects of the "Outline of the National Medium- and Long-Term Program for Science and Technology Development (2021-2035)," "the responsibility system of reviewers will be promoted, small peer review will be strengthened, and the number of application and industry experts will be increased in application target-oriented basic research reviews." The terms "responsibility system of reviewers" and "application target-oriented basic research review" are very noteworthy.

[139] [21-036] Ministry of Science and Technology, "Commitment to Providing an 'Ideal Habitat' for Innovation Talent from All Over the World," Pekin Tayori, May 11, 2021, JST Beijing Office, https://spc.jst.go.jp/experiences/beijing/bj21_036.html (accessed December 18, 2021)

[140] [21-054] Chinese Academy of Sciences Strengthens Use of Young Researchers in Key Research Positions, Pekin Tayori, November 9, 2021, JST Beijing Office, https://spc.jst.go.jp/experiences/beijing/bj21_054.html (accessed December 21, 2021)

end, the recently launched “Young Team Program for Stable Support in the Field of Basic Research” and “Research Program of Frontier Sciences” will be used to foster top scientists who can have an international impact on important scientific issues.

The third measure is to strengthen support for young talents. To that end, funding for research projects will be increased, and young researchers in key positions will be supported. During the 14th Five-Year Plan period, more than 50% of the new directors and deputy directors of institutes will, in principle, be under 40 years old, providing more young researchers with opportunities for development and growth. In addition, CAS’s “Leader Program” will introduce a “two-director system” to create conditions for the development of scientific excellence. Under the “Leader Program,” researchers under the age of 45 years must be at least 30% of the representatives of specific newly proposed projects and 50% of the representatives of research projects, and at least 50% of basic research projects must be used to support young talents under the age of 35 years.

Lastly, the Science and Technology Innovation Center will expand international cooperation on personnel exchange and promote the internationalization of its personnel. It will strive to attract outstanding human resources from overseas universities, research institutions, and enterprises by utilizing several national cooperation programs, including the center’s large-scale international cooperation program.

Shanghai is one of the leading regional cities for science and technology innovation in China. On October 19, 2021, the city of Shanghai released its “Opinions on accelerating the promotion of high-quality development of basic research[141].” The opinions set out 20 measures, focusing on allocating basic research fields, strengthening basic research capabilities, enhancing basic research talent, strengthening support for the basic research environment, and optimizing the environment for the development of basic research.

First, Shanghai has indicated that by 2025, basic research funds will account for approximately 12% of the city’s total R&D investment. This is a higher percentage than that of China as a whole. At the same time, the city will encourage enterprises to increase their investment in basic research (currently, enterprises in the city invest less than 2% of their funds in innovation, and investment in basic research is said to be even lower). The city will also create a sustainable and stable funding mechanism through various channels, such as the establishment of funds and donations.

Shanghai has a policy of establishing a pilot Basic Research Special Zone ahead of the rest of the country, providing long-term and stable financial support to universities and scientific research institutions in the city and supporting freedom in choosing research topics and autonomy in conducting research and using funds (the attitude behind the project has been described as “dig one well, and dig it deep”). Considering that researchers have long been calling for increased and stable long-term support, the Basic Research Special Zone will be important for the development of Shanghai’s basic research support and deployment system and will strengthen the promotion of basic research related to key areas and topics by allowing participating institutions to be proactive and take the lead. The Basic Research Special Zone program will select universities and scientific research institutions, grant them research autonomy, support free choice of topics, grant autonomy in conducting research and spending money, and provide room for reform and exploration in research organization and management systems.

The Special Zone program also emphasizes long-term, stable implementation cycles and explores a management

141 “Shanghai to Establish China’s First ‘Basic Research Special Zone’,” Hou Shuren and Wang Chun (Science and Technology Daily reporters), December 6, 2021, Science and Technology Topics No. 183, Science Portal China, Japan Science and Technology Agency, https://spc.jst. go.jp/hottopics/2201/r2201_hou.html (accessed December 18, 2021).

system that highlights cross-disciplinary, integrated research directions; relaxes regulations; and empowers researchers. The funding cycle is supposed to be five years. In addition, a cluster of world-class large-scale scientific facilities will be constructed in conjunction with this project.

2.10 Summary of guiding opinions on basic research promotion

Policy documents strongly related to the promotion or strengthening of basic research are the January 31, 2018, "Opinions of the State Council on the overall strengthening of basic scientific research" (see section 1.2.5.3) and the January 21, 2020, "Guidelines for activities to strengthen basic research and achieve 'Zero to One'" (see section 1.2.5.8). These documents on basic research promotion recognize that basic research depends on the free inspiration of scientists and requires stable long-term support. Further, its achievements should be evaluated from an academic perspective. However, although the wording has been softened, there is still an emphasis on measures to promote a close relationship between basic research and applied research and to utilize the specialized capabilities of enterprises to lead to innovation. In "Perspectives on the U.S.-China Decoupling Theory," former ambassador to China Miyamoto Yuji denies the common belief that Chinese economic reform began in 1978. Miyamoto states that it took time for China to determine the content of the policy itself, that "socialism with Chinese characteristics" is a policy whose concrete content is gradually being formed, and that the inner workings of the Communist Party remain a process of trial and error[142]. In other words, China is gradually determining the content of its policies through trial and error. Nevertheless, the aforementioned close relationship between basic and applied research has been consistently maintained as a policy for about 30 years and has not been subject to trial and error. This is where the problem lies. This policy demonstrates that basic research can never escape the control of the state.

At a press conference on October 21, 2020, Minister of Science and Technology Wang Zhigang stated, "Applied basic research, technological innovation, innovative uses of technology, and industrialization are all involved in scientific research. Among them, basic research can be likened to the source of a waterway." He added, "Basic research and underpinning technological R&D have been taken as the breakthrough point for sci-tech innovation. We insist on the combination of free inquiry and goal orientation; focus more on original orientation and questions of basic research found in economic and social development and industrial practice; and promote the integration of basic research, applied basic research and technological innovation, so as to bring into full play the underpinning support and guiding role of basic research to sci-tech innovation[143]." The phrases "combination of free inquiry and goal orientation" and "integration of basic research, applied basic research and technological innovation" demonstrate an old-fashioned attitude. In other words, research is conceived as a linear model. At the same press conference, Minister Wang stated that the next step is to "put basic research and application-oriented basic research higher on the agenda of China's science and technology work" and that China will "reform and improve the mechanism for project development," "further increase investment in basic research," "offer better services to scientists and researchers

142 Miyamoto Yuji, Introduction, "Perspectives on the U.S.-China Decoupling Theory: The Complexity of Bilateral Relations and China's Unpredictability," p. 28, "The Falsehood of the U.S.-China Divide," Miyamoto Yuji and Ijuin Atsushi, Japan Center for Economic Research, June 7, 2021

143 《科技部：把基础研究和应用基础研究摆在更加重要的位置》, People's Daily Online, October 21, 2020, http://scitech.people.com.cn/n1/2020/1021/c1007-31900951.html (accessed June 10, 2021)

dedicated to their work," and "support them in breaking new ground." It is unclear what exactly these "better services to scientists and researchers" entail. Perhaps, the intention is to support free and original research without the Party's intervention.

However, in the background, there is a glimpse of the idea that if the State, in this case the Party, guides scientists and researchers on scientific issues it believes it can lead, and if it invests abundant and stable resources in a free environment, it can open the way for groundbreaking discoveries and inventions. This is tantamount to asserting that the CPC, under its own leadership, can implement in a more feasible and efficient manner the process by which major industrialized countries have been striving to find discoveries that will lead to innovation.

At the 19th CPC Central Committee press conference on October 30, 2020, Wang Zhigang stated that China "identifies self-reliance and self-strengthening in science and technology as being the strategic support to China's national development." He added that the government hopes "to learn more of the advanced experience from the rest of the world and share more of China's scientific and technological achievements and contribute Chinese wisdom to tackle global challenges," emphasizing the policy of balancing self-reliance and self-strengthening with open cooperation[144].

The Fifth Plenary Session of the 19th CPC Central Committee approved the CPC Central Committee's Proposals for the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives through the Year 2035 (below, "proposals"). Thereafter, information about the plan and policy objectives were disseminated to the public by various organizations in China, and a guide to the proposals was published by People's Publishing House, a state-run comprehensive publishing house, in November 2020. The booklet was entitled "Communist Party of China (CPC) Central Committee's Proposals for Formulating the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives through the Year 2035" and its editors included President Xi Jinping, Premier Li Keqiang, and other members of the Politburo Standing Committee of the Communist Party, as well as many other key Chinese figures. The Minister of Science and Technology, Wang Zhigang, also contributed to these proposals, which are described below[145].

Of course, in the booklet, the Minister emphasizes the importance of "adhering to the position that innovation is at the core of China's modernization construction, making independent science and technology a strategic pillar of national development, perfecting the mechanism of the science and technology innovation system for innovation-driven development, and forming new advantages in all areas." Although it will not be repeated here, what is striking is the paragraph on "ensuring the soundness of mechanisms to support investment in cutting-edge basic research" in the latter part of the text. While calling for reforms in various aspects of science and technology management, this paragraph reiterates previously presented goals such as achieving "Zero to One" and emphasizes that "by practicing national security, industrial development, and civilian improvement, challenges in basic research will be clarified and applied research will be made to lead basic research." It seems that basic research must always be aimed at application, which is clearly different from the approach to basic research promotion in major developed countries. According to

144 [21-004] "14th Five-Year Plan" Press Conference of Science and Technology Minister Wang in Relation to the "Proposals" of the Fifth Plenary Session, Pekin Tayori, January 28, 2021, JST Beijing Office, https://spc.jst.go.jp/experiences/beijing/bj21_004.html (accessed December 19, 2021)

145 [21-010] "14th Five-Year Plan" Building a New Mechanism for Science and Technology Innovation, Pekin Tayori, February 22, 2021, JST Beijing Office, https://spc.jst.go.jp/experiences/beijing/bj21_010.html (accessed December 21, 2021)

Kawashima Shin, "Science and technology have already become one of the resources of legitimacy for the Communist regime, and while the government will address this as a top priority, excessive government leadership may result in the loss of the groundwork for innovation[146]."

With the above in mind, we would like to summarize some features of the aforementioned policy documents on basic research published in 2018 and 2020 (here referred to as the "2018 Basic Research Document" and the "2020 Basic Research Document," respectively).

(1) First of all, these documents confirm that basic research is designed under the leadership of the State, and relevant policies are formulated and implemented in the belief that by concentrating human, financial, and other resources, it will be possible to open new frontiers of research. In the 2018 Basic Research Document, chapter "6. Optimizing the mechanism and environment for basic research development," section "(16) Strengthening unified planning and coordination of top-level basic research design" sets forth policies to "strengthen unified planning, concentrate resource elements, focus on the leading edge of global scientific and technological development, and strongly promote original innovation." Moreover, these policies will be implemented as follows: "Under the mechanism of a joint meeting among government agencies managing national science and technology plan projects (special projects, funds, etc.), a basic research strategy advisory committee will be established to review and judge the development trends of basic research, develop basic research strategy consulting, and make recommendations on critical needs and work allocation in China's basic research." In other words, the idea is that by setting "targets," gathering "wisdom," and systematically allocating resources, China will be able to achieve the desired results. In the 2020 Basic Research Document, chapter "8. Strengthening management services," section "(20) Strengthening harmonization of planning and unified implementation" states that "a special committee for strategic consulting in basic research will be established to strengthen top-level design and unified coordination of basic research, and strategic computing will play a role in the process of identifying development trends and critical needs in basic research and planning critical tasks." The intended role of "strategic computing" mentioned at the end is unclear, but the stipulations that precede it are almost identical. In essence, this can be seen as an attempt to conduct resource allocation in a systematic and planned manner under the guidance of the State, as opposed to evaluations that focus on frontier research such as those conducted in grant reviews by funding agencies such as the NSF and NIH (National Institute of Health) in the United States. It is unclear how this approach will work. In other words, a sort of competition has historically existed between an approach in which researchers exchange scientific and intellectual information with peers, freely explore the frontiers of research, and allocate resources through peer review, on one hand, and an approach in which national organizations seek to define the frontiers of research in the form of advice and guidance and assemble and allocate resources considering the key economic and social needs of the nation, starting from basic research, on the other hand. The Communist Party contrasts a system built on fostering a free research environment, such as that of the United States, with a system of top-down leadership under a national framework.

(2) Regarding methods of financial support for basic research, the need for stable support[147] for basic research is important for all countries, and the issue of how to construct the relationship with competitive funds is an interesting

[146] Kawashima Shin, The 21st Century Public Policy Institute ed., "Three Elements for Understanding Contemporary China: Economy, Technology, and International Relations," August 25, 2020, Keiso Shobo, p. 33.

[147] Stable support here refers to the central management expenses provided by the government as institutional subsidies, which in Japan would include management expense grants.

perspective in China and beyond. The 2018 Basic Research Document states in its Basic Principles: "Strengthen stable support and optimize the R&D investment structure. Further enhance stable support for basic research through central government funding; establish diversified basic research investment mechanisms; and guide and encourage local, corporate, and social forces to increase investment in basic research. Establish investment mechanisms in which stable support and competitive support are balanced with each other to boost the overall development of scientific research, human resource training, and base construction." The document thus calls for a balance between "stable support" and "competitive support." In addition, section "(17) Establishing diversified investment mechanisms for basic research" emphasizes the importance of "long-term" support by stating that "the central government will further expand its financial support for basic research and develop long-term and stable support mechanisms for universities, scientific research institutes/institutions, and scientists." The 2020 Basic Research Document, on the other hand, begins with chapter "1. Overall Concept," which states: "As well as providing long-term and stable support for basic research and focusing on areas of advantage, we must go a step further to highlight key points and identify what is necessary and what is not." Although it repeats the same policies as the 2018 Basic Research Document, this document appears to caution against wasteful investment. Section "(21) Strengthening stable support through central government funding" continues to call for the coordination of stable and competitive support by "strengthening stable support for basic research through central government funding and establishing funding mechanisms that balance sound and stable support with competitive support."

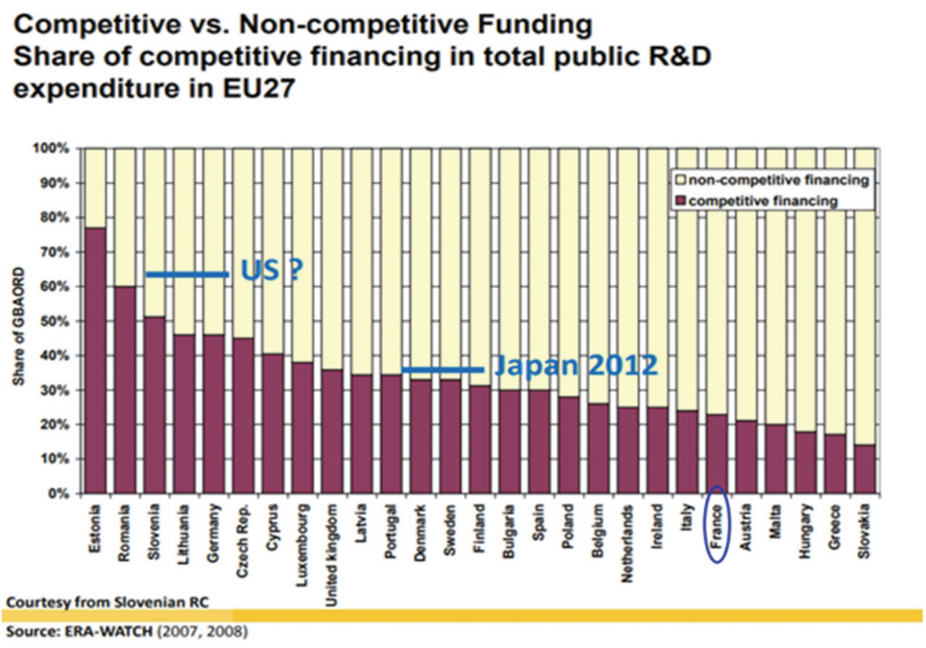


Figure 2: Share of competitive vs. non-competitive funding in EU27 countries

Source: See footnote 149

This balance between stable and competitive support, or in other words, between institutional subsidies and competitive funding, is a common policy issue in major countries as they explore ways to invest in R&D, whether early or late. The European Research Area (ERA) has a set of priority policies to help member states create the best possible R&D systems. These include "more effective national research systems" such as "effectively designed and efficiently functioning national research and innovation systems deriving maximal value from public money." To that end, the goal is to implement "better alignment of national policies with shared European priorities, applying the core principles of international peer review to funding organizations, finding a satisfactory balance between competitive and institutional funding and investing in wider education and innovation systems[148]." In other words, the aim is to find a satisfactory balance between institutional and competitive financial support. China's focus on this issue in 2018 is a natural step in the country's exploration of how to finance R&D in general. However, the question is how to "balance" the two forms of support. There is no established theory about this balance—only general trends are known. Incidentally, we came across the following information as part of our ERA-related activities. Although this is somewhat out of date, Figure 2 uses data from 2007/2008 to compare the balance of competitive and non-competitive funding for the (then) 27 EU member states. The comparison is very interesting, although it lacks specific background information such as findings from U.S. and Japanese data. Moreover, the variability of the data does not allow us to draw general conclusions about how certain amounts of competitive funding contribute to the advancement of science, technology, or basic research. However, it is safe to say that it is important for a country to find the best possible balance through a certain amount of trial and error. The ERA policies can be understood as highlighting the importance of this very aspect. It is worth noting that the U.S. has a high rate of competitive funding. The extent to which China aims to achieve balance in its financial support (in this case, not necessarily only for basic research) should be closely observed.

(3) Next, let us look at the status of evaluation. The 2018 Basic Research Document, in its section on "Developing classified evaluation mechanisms," specifically addresses project management, stating that "project organization, reporting, evaluation and review, and policy-making mechanisms that fit the laws of basic research will be developed, and when selecting basic research projects, more attention will be devoted to research directions, human resource teams, and their innovation capabilities." Here, "classified evaluation" means that evaluation should not be based simply on the positioning of basic research, but on the identification of the direction of basic research. More specifically, it is stated that "a trial of differentiated evaluation of basic research will be developed, classified evaluation will be conducted for each university and scientific research institute/institution, commensurate criteria and procedures will be established, and evaluation mechanisms centered around the quality of innovation and academic contribution will be developed." A clear emphasis is placed on basic research aimed at innovation at the stage of evaluation. This is also reflected in the choice of personnel with strong innovation skills during project selection. Evaluation will be conducted according to the classification of basic research mentioned above: "For free exploratory basic research, we will mainly evaluate the originality and academic contribution of the research and explore long-term evaluation and international peer review. For goal-oriented basic research, we will mainly evaluate the effectiveness in solving key scientific problems, strengthen process evaluation, establish supervision and management mechanisms with long-term effectiveness, and enhance the efficiency of innovation." In particular, it is very interesting to note that according to this document, "international peer review" will be sought for "free exploratory basic research," although

148 ERA PROGRESS REPORT 2018 REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT, European Research Ares, 2018 Report, p. 5 file:// jstoa.local/%E5%80%8B%E4%BA%BA%E3%83%87%E3%83%BC%E3%82%BF/%E5%80%8B%E4%BA%BA%E3%83%87%E3%83%BC%E3%82%BF_006/takayuki.shirao.kf/EU/data/KIAR19001ENN.en.pdf (accessed June 2, 2021) The ERA was established in 2000 to promote cross-border research cooperation within the EU, aiming for better cross-border cooperation building of critical mass, and continent-wide competition.

it is unclear how this will be implemented. In contrast, the 2020 Basic Research Document begins with the goals of "establishing an evaluation system that encourages fundamental innovation" and "promoting an evaluation system for representative works." In other words, the evaluation of people and teams reaffirms the emphasis on scholarly achievements in terms of "emphasizing the scientific standard and scholarly contribution of representative works and the academic content of papers, avoiding the tendency to focus on papers, titles, academic background, and awards." Classified evaluation criteria are defined as follows: "Basic research projects will be evaluated with emphasis on the originality and scientific value of new discoveries, new principles, new methods, and new laws and regulations, with a focus on the level of representative results. Basic research application projects will be evaluated based on their role in solving scientific problems that are key to economic and social development and critical national security needs, with an emphasis on their applied value." However, in the State Key Laboratory evaluation system, emphasis is placed on innovation effectiveness and accomplishment of national missions: "State Key Laboratory evaluation will adhere to the periodic evaluation and classified review system. The evaluation system will be built around the quality of innovation and academic contributions, and the status of accomplishing national missions and the effectiveness of innovation will be important evaluation criteria." In conducting the evaluation of State Key Laboratories, higher education institutions and scientific research institutes "will be the pilot sites for the development of evaluation."

As mentioned above, if China's research system, in which the State is trying to play a systematic and planned role in promoting basic research, is to function as originally designed, this system will not be complete unless the results of the above evaluation, including international peer review, are reflected in the deliberations of the abovementioned "basic research strategy advisory committee" and "basic research strategy consulting." Although the details of the institutional design are still unknown, perhaps new frontiers of research can be opened only when this cycle is closed.

(4) Let us look at the creation of centers for basic research. The 2018 Basic Research Document states that the government will "strengthen the construction of basic research and innovation centers" and specifically "optimize the allocation of State Key Laboratories, rely on universities, scientific research institutes and research centers and core enterprises, among others, to design and build a series of State Key Laboratories and Key Defense Science and Technology Laboratories for cutting-edge, emerging, interdisciplinary, and peripheral departments, as well as poorly resourced departments, and promote the establishment of national interdisciplinary research centers." The government will also "strengthen the construction of innovation capacity of science institutes and research centers converted into enterprises, guide science institutes and research centers converted into enterprises to focus more on the cutting edge of science and basic applied research and create original innovation centers to promote industry development." The former initiative will be led by State Key Laboratories and other institutions, and the latter will be led by business organizations. In either case, this can be interpreted as the creation of centers that will directly link basic research and innovation. The term "center" is used repeatedly in other passages as well. In essence, this refers to the creation of centers that can take on national missions related to innovation, as represented by "seeking a mechanism to directly entrust national science and technology innovation centers to take on national scientific research missions." The term "center" is used infrequently in the 2020 Basic Research Document, which states, "(16) We will fully utilize the ripple effects and traction role of State Key Laboratories. State Key Laboratories will fulfill their role as innovation bases and act as promoters and planners of key national technology missions, taking the initiative in leading the technology force in related fields throughout China, demonstrating collective advantages, jointly developing strategies to overcome difficulties, and having a ripple effect and a leading role in the industry. We will seek to make State Key Laboratories independent responsible entities and strive to establish a mechanism to take charge of national technology missions."

Other than that, this section only makes general statements, such as stating that "an international innovation cooperation platform will be established" to promote international cooperation. The 2018 Basic Research Document went too far in proposing the creation of several centers, which tended to cause confusion with existing organizations. We will follow up on how these centers directly linking basic research and innovation have developed from the 2020 Basic Research Document to the 14th Five-Year Plan and beyond.

(5) Finally, let us compare provisions related to human resources. In the 2018 Basic Research Document, "Chapter 4. Expanding human resource teams in basic research" states, "(10) We will develop strategic scientific and technological human resources and scientific and technological leadership personnel at the international level. We will seize international development opportunities; innovate mechanisms for training, introducing, and using talents around the critical needs of the country; accelerate the promotion and implementation of high-level talent introduction and training programs, such as the national 'Thousand Talents Program' and 'Ten Thousand Talents Program,' introduce talents from many areas and widely attract outstanding human resources. We will further establish scientist work studios in areas of scientific research where the country has an advantage and train a group of promising, globally minded, strategic scientists. We will establish and improve the human resource mobility mechanism and encourage the rational flow of human resources among universities, scientific research institutes and research laboratories, and enterprises." China will, thus, seek out and organize talented young people in areas where it has an advantage. This is also true for the 2020 Basic Research Document. As will be further clarified in the specific policies to be developed in detail in the 14th Five-Year Plan, the establishment of a science and technology management system that focuses on "people" and "talent" will be thoroughly implemented.

(6) The "Key Basic Research Projects" that appear in the 2020 Basic Research Document are not found in the 2018 Basic Research Document. Although this is one of many uses of the term "key," it likely refers to basic research projects related to "key scientific problems," "key basic areas that necessarily involve cutting-edge and strategic competition," "national key basic research missions," and so on, identified in the 2018 Basic Research Document. Notably, the direction expressed in the reforms related to the formation of Key Basic Research Projects is to "improve the formation style and management methods of basic research projects in terms of guide creation style, effective competition, openness, project review mechanisms, formation of review expert teams, and so on." Specific details of the implementation of these reforms need to be examined. The statement that China will "establish a green channel policy for application, evaluation, and review of original projects, and a mechanism to apply at any time[149]" is particularly interesting, as this would be a system that considers the process by which researchers conduct basic research. In particular, the "mechanism to apply at any time," as described in section 5.6, mimics the application process of the U.S. DARPA. Although it increases the burden on funding agencies, it is a method that immediately responds to the "inspiration" of researchers.

Overall, this perfectly illustrates the process of successfully constructing basic research and achieving innovations that lead to social and economic development.

[149] According to a note from the JST Beijing Office, a "green channel" is "a simple, fast, and secure channel, here referring to simplification."

2.11 Summary of guiding opinions on scientific research management reform

This chapter has covered various guiding opinions on reform, including the March 23, 2015, "Opinions on accelerating the implementation of the innovation-driven development strategy through deepening reform of systems and mechanisms." Among them, the July 31, 2016, "Opinions on further development policies, including management of funds for scientific research projects funded by the central government," are bold in their effort to deepen reform of scientific research project management, which has not progressed smoothly in recent years. To help readers understand the various aspects of these far-reaching reforms, we will review the main points of the major guiding opinions below. We will summarize some of the most important points in chronological order.

The first measure is to simplify, expedite, and streamline inspection and evaluation procedures for budget preparation and management, aiming to "**delegate power, streamline administration, and optimize government services**[150]." All of these improvement measures apply to the central government's science and technology programs and to the operations of universities and scientific research institutes.

① The provisions for "Improving the management of funds" include "simplifying budgeting and delegation of budget adjustment authority," "increasing the ratio of indirect costs and strengthening performance-linked incentives," "clarifying the scope of personnel costs and eliminating percentage restrictions," and "improving the method of retaining and handling surplus funds carried forward."

② As for "Travel and conference expense management," the opinions mention "improving the management of travel expenses" and "improving the management of conference expenses."

③ "Purchase management for scientific research equipment and facilities" is addressed by "improving the management of purchases."

④ "Infrastructure construction project management" will be addressed by "expanding management authority over infrastructure construction" and "simplifying the review of proposals for infrastructure construction projects by competent departments."

⑤ The provisions for "Standardizing management and improving services" will include "strengthening corporate responsibility and standardizing fund management" and "strengthening comprehensive collaboration and simplifying inspection and evaluation procedures."

⑥ The two most important tasks for "Strengthening institution building and work management and ensuring the full implementation and effectiveness of policy measures" will be "the scientific and rational compilation of project budgets by improving budget compilation manuals" and "the integration of monitoring survey results by the Ministry of Finance and the Ministry of Science and Technology into the credit management system."

Other features include the "**breaking the four only**" by de-emphasizing titles and educational background. As mentioned above, General Secretary Xi Jinping's speech at the joint Congress of Academicians on May 28, 2018, introduced the idea that "the personnel evaluation system is unreasonable, and the tendency to emphasize only papers, academic background, and titles is still strong." This led to a coordinated "initiative to break the four only" by the Ministry of Science and Technology, the Ministry of Education, the Ministry of Human Resources and

150 See footnote 92.

Social Security, CAS, and the Chinese Academy of Engineering since October of the same year. It further led to the statement, in the March 2019 Report on the Work of the Government, that China would "reform and improve mechanisms for training, employing, and evaluating capable people and provide better services for students returning from overseas and foreign professionals."

The July 18, 2018, "Notice of the State Council on measures to optimize scientific research management and enhance scientific research performance" is a general opinion. It promoted the following measures: "Optimizing scientific research projects and fund management," "Implementing an evaluation incentive system that encourages innovation," "Taking measures to strengthen the performance evaluation of scientific research projects," "Strengthening the responsibility of each department," and "Selecting institutions with innovative capabilities and potential, a remarkable track record, and good credit standing, and implementing model **green channel** reform projects."

Finally, the August 13, 2021 "Opinions of the Central Office of the State Council on the reform and improvement of fund management for scientific research funded by the central government" are taken as general guiding opinions. They reiterate several improvements that have been made in the past: "Expanding autonomy in the management of research funds," "Improving mechanisms for research funds," "Expanding incentives for researchers," "Reducing the administrative burden on researchers," "Innovating methods of funding and supporting research," and "Making research performance management mechanisms sounder." However, the content is more in-depth. For example, in relation to "budgeting," "direct costs are consolidated from nine budget items to three budget items (equipment, operations, and labor)," and "explanations can be omitted from cost estimations except for equipment costs over CNY 500,000." As for "delegation of budget adjustment authority," "the authority to adjust the budget for equipment costs is delegated to the project host institution, and the authority to adjust the budget for operations and labor costs is delegated to the principal investigator." Regarding "relaxation of restrictions on use of funds," "restrictions on the percentage of expenses or use of research funds for basic research and human resource projects are relaxed," and the so-called lump-sum system is implemented to increase researchers' autonomy and flexibility in the use of research funds. "Improving mechanisms for research funds" consists of "rational formulation and deployment of funding plans by the project management department," "guarantee of research needs with respect for the opinions of principal investigators," "earlier disbursement of research funds," and "permission for project implementing organizations to continue to use funds after passing the performance evaluation, rather than being obliged to return them," as well as "increase in the percentage of indirect expenses," "expansion of incentive grants," and "expansion of the scope of labor cost payments" with the aim of "expanding incentives to researchers." To "reduce the administrative burden on researchers," steps are taken to "assign financial assistants to scientific research projects to provide specialized services such as budgeting and reimbursement and make it possible to cover related labor costs with project funds," as well as to "improve advance payment of travel expenses for invited guests," "enable fixed amount payment for domestic travel expenses and accommodation expenses for which invoices are difficult to obtain," and "digitize receipts and other expense reports, moving toward a paperless system." Finally, the "simplification of acceptance inspections" involves simplifying project inspections to conduct a comprehensive performance evaluation only once at the end of the project. Through the "optimization of procurement of research equipment and facilities," the need to bid for research equipment and facilities is eliminated, and expenses related to international cooperation and exchange of researchers are not included in the so-called "**three public expenses**[151]" (expenses for entertainment, foreign travel, and purchase and operation of official vehicles paid for with public funds). Therefore, expenses related to international cooperation are not restricted by requests to expand the scope of the zero tolerance policy for the "three public expenses," achieving more flexibility in the use of international exchange funds. A management model known as "**budget + negative list**[152]" (a system that lists only items that should not be used) is promoted to relieve researchers from accountability, "increase autonomy in the use of research funds," and further "allow scientific and technological achievements and intellectual property rights produced with the support of central government funds to be acquired by the new research institutions," allowing them to "independently pursue applications and commercialization."

Further reforms that should be emphasized are **open competition**, which calls for introducing "an open competition mechanism to select the best candidates to lead key research projects" and work toward technological breakthroughs (Report on the Work of the Government, Third Session of the 13th National People's Congress, May 22, 2020); **horse-racing**, which institutionalizes competition; and **engineer responsibility systems**.

China has also extensively studied the features of the excellent and much-imitated U.S. DARPA system, which are cited for reference here. These features are "clarification of the authority, initiative, and responsibility of the project manager (PM) as process owner," "highly fluid organization and operation," "tolerance for failure and clarification of responsibility," "system that allows for long-term investment," and "emphasis on valuable basic research and long-term investment[153]." Although this is different from the guiding opinions mentioned above, the May 30, 2018, Central Office of the Communist Party of China and Central Office of the State Council "Opinions on further strengthening credit building in scientific research" adopt an "evaluation system that is tolerant of failure."

The above is reiterated in the key points of the amendment to the Progress of Science and Technology Law by the Standing Committee of the National People's Congress of China in December 2021, as described below.

① Strengthen basic research, enhance national strategic science and technology capabilities, and improve the national innovation system. Promote breakthroughs in key core technologies and optimize the deployment of regional innovations.

② Improve the management system for scientific and technological personnel, strengthen service awareness and assurance capabilities, and simplify the management process. Avoid duplicate inspections and evaluations and reduce the burden of reviewing projects for scientific and technical personnel, etc.

③ Develop new types of innovation actors, such as new types of R&D institutions, and improve models to diversify investment entities, modernize management systems, marketize operational mechanisms, and improve flexible models to develop employment systems.

④ Raise the standard of incentives for scientific and technological personnel, solve the financing issues of science and technology enterprises, and strengthen regional scientific and technological innovation.

Please read Chapters 6 and 7 for a discussion of how the Chinese research system should be viewed in light of these policies.

151 See footnote 154.

152 See footnote 155.

153 Takizawa Minako, "A big question for everyone: Why was Japan's development of a COVID vaccine delayed? The unfortunate reason discovered by an in-depth investigation," July 8, 2021, https://gendai.ismedia.jp/articles/-/84776?page=6 (accessed September 5, 2021).

3 China's Investment in and Perception of Basic Research

3.1 Investment in basic research

Having described the evolution of policies related to the promotion of basic research, we will now look at the amount of investment in basic research in recent years. Figure 3 below shows the amount of investment in basic research through 2019[154]. Investment has increased from CNY 5.22 billion in 2001 to CNY 82.29 billion in 2016 and has reached CNY 133.6 billion in 2019. China's successive policy documents introduced thus far have called for the "continuous promotion of basic research." As a result, the amount of investment in basic research has actually been increasing.

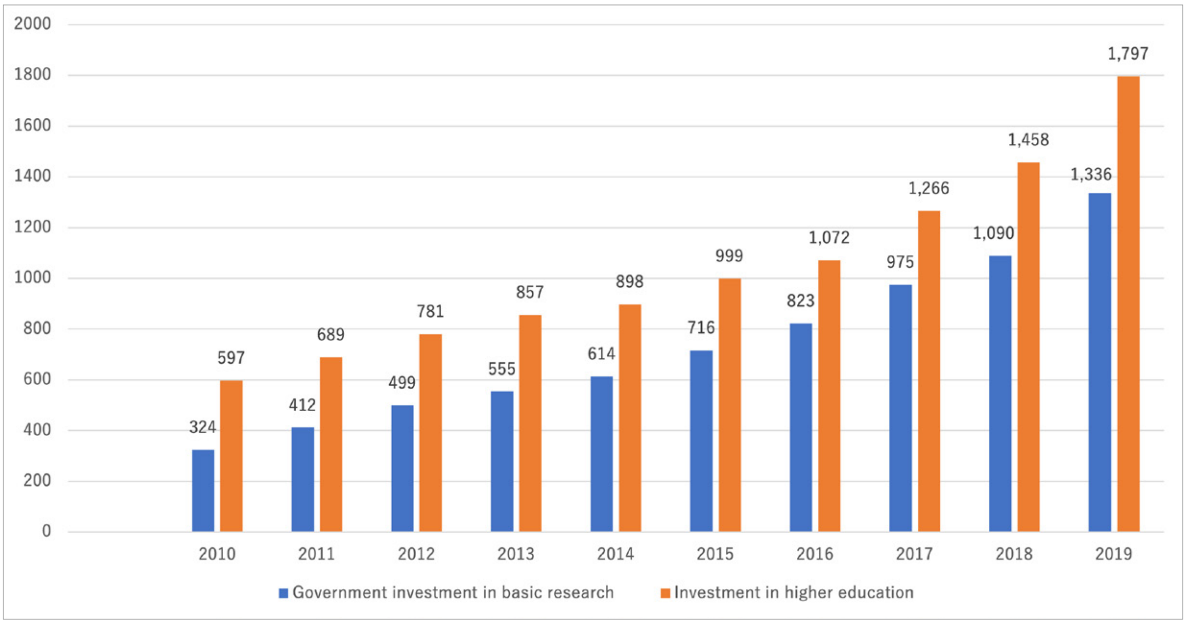


Figure 3: Trends in central government investment in higher education and basic research (CNY 100 million)

Source: Prepared by the authors based on OECD Science and Technology Statistics[155]

[154] Wei Huang, "Advancing basic research towards making China a world leader in science and technology," National Science Review, volume 5, Issue 2, March 2018, pages 126-128, https://academic.oup.com/nsr/article/5/2/126/4816745 (accessed June 7, 2021)

[155] OECD Science and Technology Statistics, Gross domestic expenditure on R&D by sector of performance and type of R&D, https://stats.oecd.org/ Index.aspx?DataSetCode=GERD_TORD# (accessed July 27, 2021).

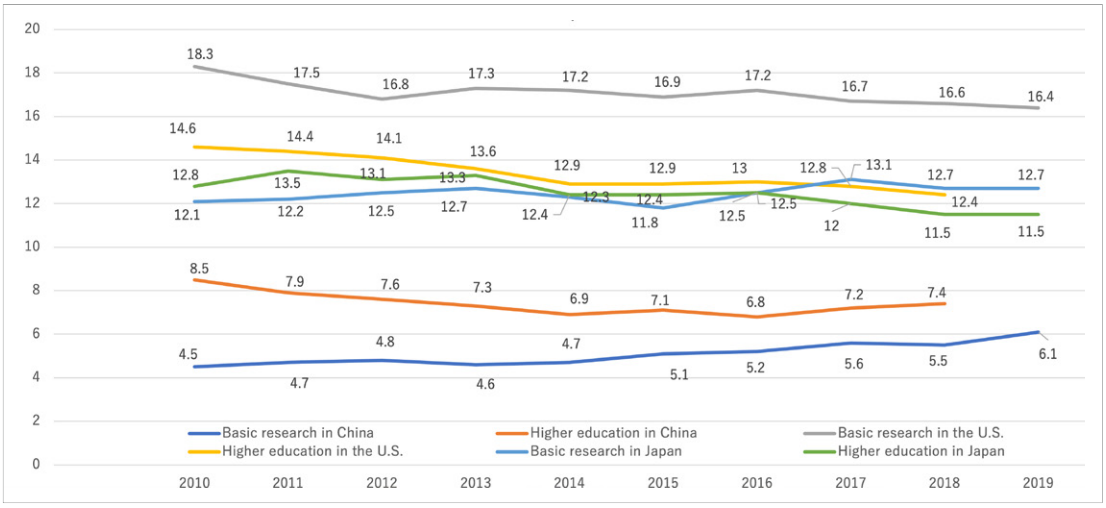


Figure 4: Trends in rate of investment in higher education and basic research in the U.S., China, and Japan (%)

Source: Prepared by the authors based on OECD Science and Technology Statistics[156]

On the other hand, considering the ratio of investment in basic research to total R&D investment in major countries[157], as shown in Figure 4, the proportion of investment in basic research in China increased only slightly from the 1990s through the 2000s; it has not increased since then. In the case of Japan and the U.S., the trends show that consistently high levels were maintained.

Although not yet included in these statistics, following the expansion of investment in basic research based on the 2018 "Opinions of the State Council on the overall strengthening of basic scientific research," the growth rate in 2019 was 16.9%, with an investment of CNY 133.66 billion[158] (about USD 20.4 billion), accounting for a 6% share of R&D investment. The ratio of investment in basic research to total R&D investment is expected[159] to reach 6.6%[160] in 2020, exceeding CNY 150 billion (with an actual 12.6% increase to CNY 150.4 billion, or about USD 23 billion[161]). Local governments also invest in R&D, but it is estimated that 90% of basic research investments come from the central government. It is reported that basic research expenditures in 2021 were up 15.6% from the previous year and accounted for 6.09% of total R&D investment for the entire society (the amount of this investment is not shown)[162]. These figures indicate that the proportion of investment in basic research in China has not increased much relative to the target of 8% or more.

156 *Ibid.*

157 Indicators of Science and Technology (2019 edition)

158 People's Daily Online, *op.cit,*.

159 "China to increase spending on basic research," Macau Business Media, March 29, 2021
MNA International https://www.macaubusiness.com/china-to-increase-spending-on-basic-research-2/ (accessed June 4, 2021)

160 China to boost support for basic research over the next five years: minister, Xinhua| 2021-03-08 21:48:26, http://www.xinhuanet.com/english/2021-03/08/c_139794983.htm (accessed June 4, 2021)

161 National Bureau of Statistics of China announcement, "China's R&D Expenditures Exceed 40 Trillion Yen, Proportion of Basic Research Funds Increases," Yahoo News, March 18, 2021,
https://news.yahoo.co.jp/articles/db394c9c5029714150a0d7bba88d 64066081f520 (accessed July 20, 2021)

162 Science China Portal, Science and Technology News, February 28, 2022, "R&D Expenditures in China Increased by 14.2% to 2.79 Trillion Yuan Last Year," https://spc.jst.go.jp/news/220204/topic_6_01.html (accessed May 4, 2022)

The amount of investment in basic research in China is controversial. According to Liu Li, a science policy researcher at Tsinghua University, this investment does not include labor costs, unlike statistics compiled using the OECD methodology.[163,164] Methods to understand not only China's amount of investment in basic research but China's R&D investment, in general, are unclear. In the above-mentioned paper, Isa notes, "the scope of what is defined as 'research and development' may be broader than we realize. In other words, the terms 'R&D,' 'high-tech,' or 'science' may include things we do not recognize as such." He concludes, "It is clear that China's 'R&D expenditures' can include any expense that is even tangentially related to R&D[165]." In his book, Hayashi Yukihide also raises the question of "whether the R&D expenditures of Chinese private enterprises include funds that are somewhat different from those of Western countries, Japan, and South Korea." He states that because of tax exemptions, "even relatively unrelated expenses are likely to be included in R&D expenditures." Hayashi concludes that given enterprises' willingness to introduce technology from Europe and the U.S., "it is likely that expenses related to the introduction of such technology are also included in R&D expenditures[166]."

However, according to the interpretation of key statistical indicators by the National Bureau of Statistics of China, "Total R&D expenditures refer to actual expenditures on R&D activities (basic research, applied research, and experimental development) conducted internally by the survey unit (the organization that serves as the survey entity). In addition to direct expenditures for R&D project (topic) activities, indirect expenditures for R&D activities, such as management fees, service fees, R&D-related facility construction costs, and outsourced processing costs, are included, whereas expenditures for production activities, repayment of loans, and R&D activities outsourced to or in cooperation with external organizations are not included." Moreover, "Expenditures for R&D projects refer to actual expenditures for research and prototyping for R&D projects within the research unit in the reporting year, including personnel costs, other day-to-day expenses, purchase and construction costs of fixed assets, and outsourced processing costs, and do not include funds allocated to other units for project (issue) research commissioned by or conducted in cooperation with other units[167]."

According to this interpretation, the amount of investment in basic research in China includes almost the same expense items as defined by the OECD.

The percentage of basic research funds in major countries is shown below. China's percentage is known to be comparatively small, as already shown in Figure 4. Also, if basic research in China includes "application-oriented basic research," investment in "pure basic research" must be considered quite low.

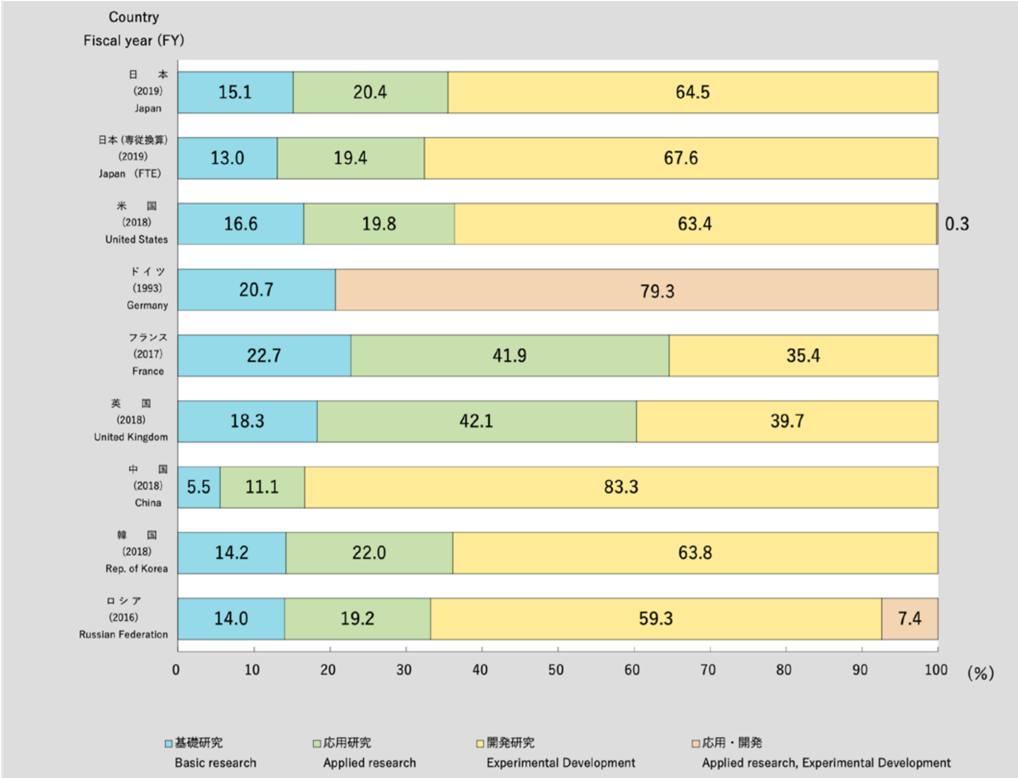
163 The Measurement of Scientific, Technological and Innovation Activities, Frascati Manual, Guidelines for Collecting and Reporting Data on Research and Experimental Development, 113p, https://www.oecd-ilibrary.org/docserver/9789264239012en.pdf?expires=1624939715&id=id&accname=guest&checksum=07BFD1102222E4450956F1711A84C962 (accessed June 29, 2021)

164 Hepeng Jia, "China's citations catching up," Nature Index, 30 November 2017 https://www.natureindex.com/news-blog/chinas-citations-catching-up (accessed 26 June 2021), and Fang Xin, "Considerations on China's basic research development" (Chinese Academy of Sciences, 235th Shuangqing Forum, accepted June 15, 2019) note that "the expenses of faculty and students engaged in scientific research at universities are included in education expenses, rather than scientific research expenses, and the costs of key scientific and technological infrastructure are accounted for separately."

165 Isa Shin'ichi, *op. cit.,* pp. 159-160

166 Hayashi Yukihide, *China as a Science and Technology Superpower*, Chuokoron-sha, July 2013, p. 178

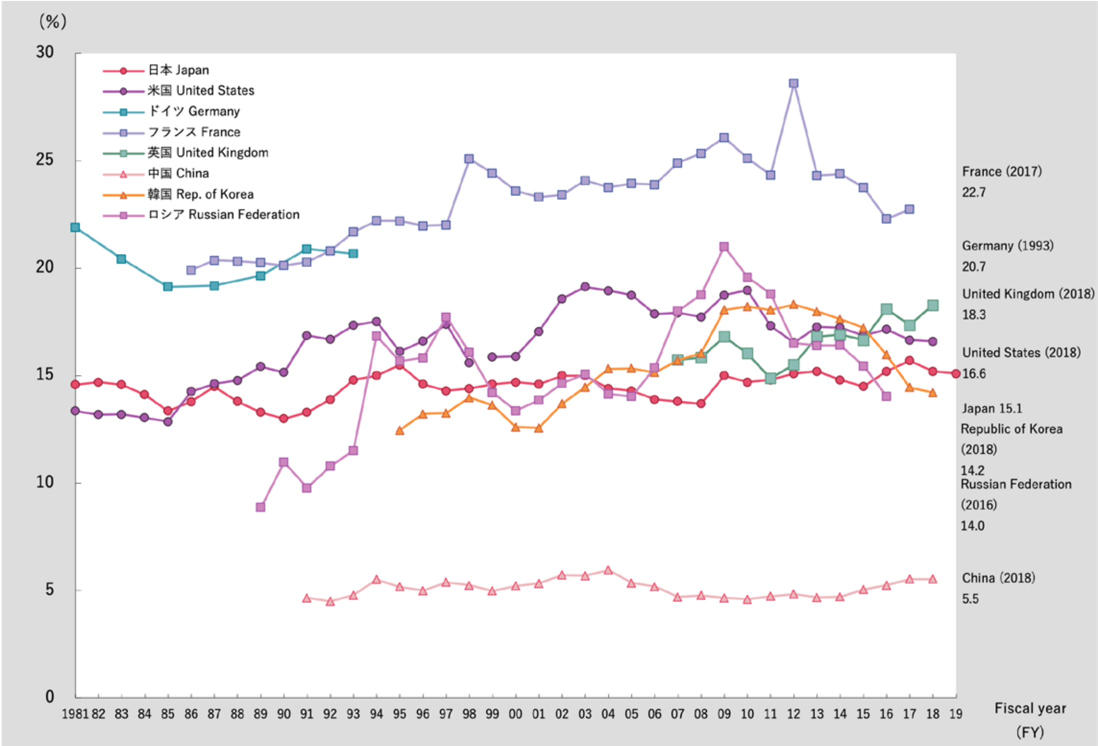
167 China National Bureau of Statistics, "主要统计指标解释," http://www.stats.gov.cn/tjsj/ndsj/2017/html/zb20.htm (accessed July 6, 2021)



Note 1: With the exception of Japan, humanities and social sciences are included in each country.
Note 2: The Japan full-time equivalent (FTE) is calculated by the Ministry of Education, Culture, Sports, Science and Technology based on data from the Statistics Bureau of the Ministry of Internal Affairs and Communications.
Note 3: Values for the United States and the United Kingdom are estimates, and values for France are provisional.
Source: Japan: "Report on the survey of research and development," Statistics Bureau, Ministry of Internal Affairs and Communications
Other countries: OECD, R&D database, Oct 2019.

Figure 5: Proportion of basic research funds in major countries

Source: Indicators of Science and Technology, 2019 edition



Note 1: Humanities and social sciences are included in all countries except Japan and the Republic of Korea until FY2006.
Note 2: Values for the United States are provisional, and values for the United Kingdom are estimates.
Source: Japan: "Report on the survey of research and development," Statistics Bureau, Ministry of Internal Affairs and Communications
Data: Other countries: OECD, R&D database, Oct 2019.

Figure 6: Trends in the proportion of basic research funds in major countries, etc.

Source: Indicators of Science and Technology, 2019 edition

Next, let us look at the amount of investment in China for each investment target institution.

As shown in Figure 7, a substantial portion of total basic research expenditures is spent on universities, with more than half being spent on universities during this period. The overall growth rate of basic research funds was 2.18 times and that of universities was almost the same, 2.13 times, which is in line with total growth. However, basic research funding by scientific research institutions also accounted for nearly 40% of the total during this period, which implies that these institutions are no less active in basic research activities than universities.

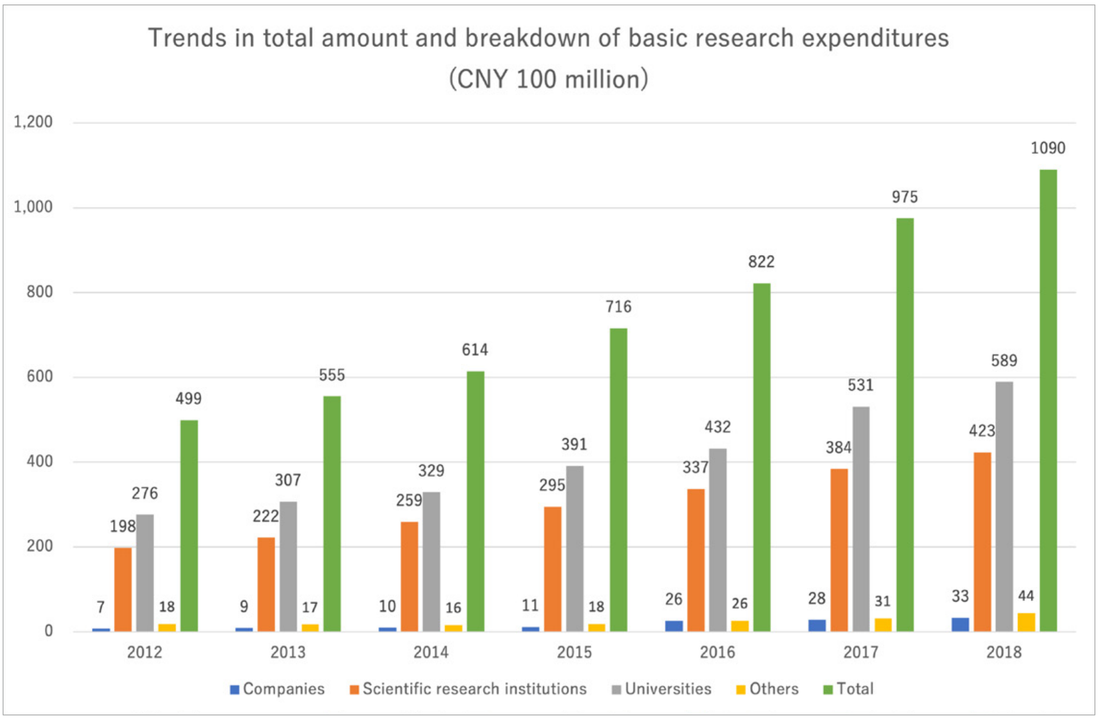


Figure 7: Trends in total amount and breakdown of basic research expenditures (CNY 100 million)

Source: Prepared by the authors based on the China Statistical Yearbook of Science and Technology[168]

In contrast, the percentage of a university's own research funds that are allocated to basic research is an important piece of information in determining the nature of a university's research. Figure 8 shows the total amount of research funds and basic research funds at universities. From just before the current administration of General Secretary Xi Jinping to 2018, total research funds increased by about 1.9 times, and basic research funds increased by 2.14 times, which is indeed a significant growth rate. The share of basic research funds increased from 35.2% in 2012 to 40.4% in 2018. However, applied research expenditures increased by 1.8 times during this period, and while experimental development costs remained at around CNY 10 billion for some time, they recently increased by 1.5 times. Including applied research, the ratio of these expenditures to the total is around 60%, suggesting that most university research occurs at the applied research stage or thereafter.

Regarding the sources of basic research funding in China, most of the expenses for free exploratory research are provided through NSFC competitive funding, and the five National Projects described below (see Table 10), which include NSFC funds, are directed to basic research (although in National Key R&D Projects, only a portion of the funding is for basic research). In contrast, 68% of basic researchers receive little or no basic research funding from their organizations[169]. The NSFC example shows that while the total amount has increased from CNY 25.058 billion in 2014 to CNY 28.081 billion in 2019, the number of applications has also increased, and the acceptance rate has decreased from 25.3% to 17.9%, especially for general projects, down from 25.4% to 19%. Furthermore, the amount

168 China Statistical Yearbook of Science and Technology, https://spc.jst.go.jp/statistics/ststats_index.html (accessed July 24, 2021)

169 Xue Shu, Zhang Wenxia, and He Guangxi, "从科研人员角度看当前我国基础研究存在的问题," Science and Technology in China, edited by the Chinese Academy of Science and Technology for Development, Ministry of Science and Technology, https://www.163.com/dy/article/GOLNMALU0514R8 DE.html (accessed December 5, 2021)

of support per project has also decreased. The NSFC example shows an average support amount of CNY 585,800 for general projects and CNY 234,200 for young researchers' projects in 2019, which is quite low in terms of support for basic research.

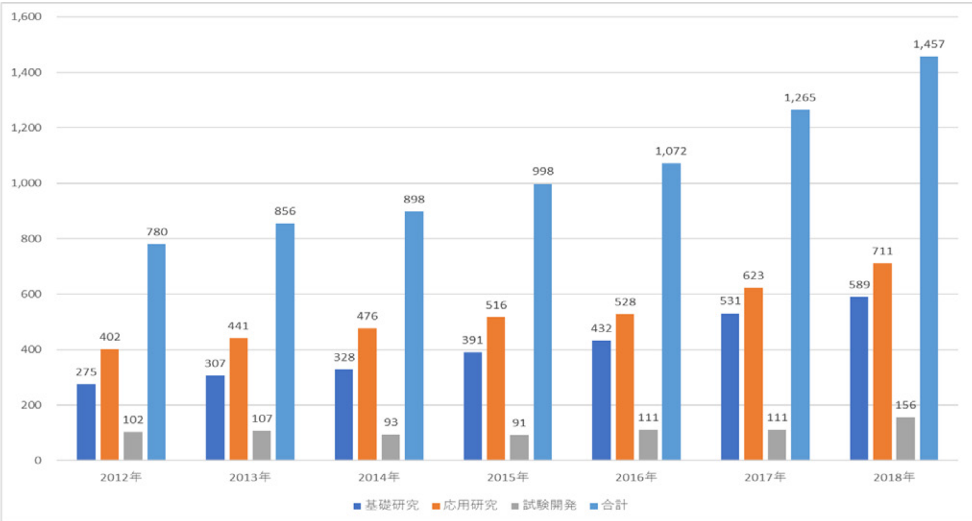


Figure 8: Trends in total research funds and basic research funds at universities (CNY 100 million)

Source: Prepared by the authors based on the China Statistical Yearbook of Science and Technology

Figure 8 shows the nature of research funds and their proportions in universities. As mentioned above, the percentage of basic research funds in Chinese universities has remained at 40%, while that of Japan was 53.7% in 2017[170]. Given that this level has been maintained for more than 30 years, it can be said that investment in basic research in Chinese universities is relatively low. Furthermore, as mentioned above, basic research in China may include a considerable amount of application-oriented research, and it is quite unclear to what extent emphasis is placed on pure basic research that will plant the seeds of future innovation.

Regarding the above trends, Sunami Atsushi's analysis of "university-affiliated enterprises" cited above[171] discusses future investment in basic research in China, noting that "Although the Chinese government has recently introduced policies that emphasize basic research, the issue of how to continue expanding basic research in the face of the constant shortage of funds will largely determine the future of research activities at universities." Today, after more than 15 years, the amount of investment in basic research at universities has remained relatively stagnant.

According to the January 15, 2020, issue of *Nature*[172], China's investment in R&D is gradually increasing, although the United States remains the leader in R&D investment[173]. While investment growth in the U.S. averaged 4.3% from

170 See Indicators of Science and Technology, 2019 edition, p. 25, "Trends in the percentage of research funds by type of activity in Japan."

171 Sunami Atsushi, *op. cit*., p. 10

172 Giuliana Viglione, "China is closing the gap with United States on research spending," Nature NEWS, 15 January 2020, https://www.nature.com/articles/d 41586-020-00084-7 (accessed August 4, 2021)

173 R&D investment in 2021 is estimated to be about CNY 2.79 trillion, up 14.2% from the previous year and equal to 2.44% of GDP (Science China Portal, Science & Technology News, February 28, 2022, "R&D Expenditures in China Increased by 14.2% to 2.79 Trillion Yuan Last Year," https://spc .jst.go.jp/news/220204/topic_6_01.html (accessed May 4, 2022)

2000 to 2017, China's growth was a remarkable 17%. The U.S. and China are now almost on par in terms of percentage of total investment in the world, at 25% and 23%, respectively. Incidentally, the number of foreign students has been declining since 2016, and the number of Chinese and Indian students who remained in the U.S. after earning their PhD decreased by 9 and 5 percentage points, respectively, from 2003. In addition, the percentage of papers published by U.S. authors that were coauthored by foreign researchers increased from 19% in 2000 to about 40% in 2018, with Chinese researchers accounting for about 25% of the increase.

Note that the total amount of funds invested in basic research by private enterprises in China is unknown. Recently, however, perhaps due in part to government initiatives, Tencent has announced its intention to invest CNY 10 billion over the next ten years in basic research fields (mathematics and materials science, biology and medicine)[174] ("New Basic Researcher Program").

3.2 Number of researchers engaged in basic research

First of all, it should be noted that it is not easy to compare the number of researchers in China with those in Japan, the U.S., and Europe. We would normally use OECD statistics, but even there, it is difficult to find consistency in the numbers; further, it is possible to examine the breakdown of the published figures. Therefore, we will quote the OECD figures verbatim, but even so there are limitations.

While the OECD Science and Technology Statistics include some statistics on the number of R&D personnel, there are no Chinese statistics on the number of personnel by field, degree, or research occupation (researchers, technicians, etc.), in the natural and social sciences. The only statistical figures included are the number of R&D personnel and the number of R&D personnel in national scientific research institutions, higher education institutions, and private enterprises. In any case, the so-called full-time equivalent conversion is applied. The data is shown in the table below.

Table 1: Trends in number of R&D personnel

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total number	2 882 903	3 246 840	3 532 816	3 710 580	3 758 847	3 878 056	4 033 597	4 381 443	4 800 768
Scientific research institutions	414 316	446 920	467 312	479 434	493 199	505 926	531 628	545 770	566 857
Higher education institutions	299 296	313 520	324 941	334 794	354 861	360 049	382 159	410 893	565 478
Private enterprises	2 169 291	2 486 400	2 740 562	2 896 351	2 910 799	3 012 081	3 119 808	3 424 779	3 668 432

(Based on OECD Science and Technology Statistics)

The total number of institutions increased by 1.7 times over a decade or so, with (public) scientific research

[174] Cao Xiuying,《10年投入100亿支持基础研究“新基石研究员项目“正式发布》, April 29, 2022, Science and Technology Daily, http://digitalpaper.stdaily.com/http_www.kjrb.com/kjrb/ html/2022-05/04/content_534615.htm?div=-1

institutions increasing by 1.37 times, higher education institutions by 1.89 times, and private enterprises by 1.69 times. The growth of higher education institutions is remarkable.

The figures for China reported in the FY2020 edition of the Indicators of Science and Technology differ from these OECD figures. While the above OECD figures encompass all related occupations as R&D personnel, those with the title of researcher accounted for 1,866,000 people in 2018[175]. This includes 370,000 people at scientific research institutions (government), 353,000 at higher education institutions, and 1,143,000 at private enterprises.

What we aim to clarify in this report is the status of promotion of basic research in China. Here, we would like to find the number of researchers engaged in basic research and compare it with Japan, the U.S., and Europe. However, OECD science and technology statistics do not provide statistics on the number of researchers by categories such as basic research and applied research for major countries, and the Indicators of Science and Technology do not provide statistics for these categories either. Therefore, international comparisons of the number of researchers from this perspective are not possible.

Meanwhile, China's own published statistics provide quite detailed figures. In August 2021, the Chinese Ministry of Science and Technology published the "2019 Analysis of Our Country's R&D Personnel Development Status" (below, "personnel analysis"), revealing statistics such as the number of R&D personnel (full-time equivalent)[176]. According to this personnel analysis, in 2019, the total number of R&D personnel was 4,801,000, that is, 420,000 more than previous year. This figure is the same as the one included in the OECD Science and Technology statistics mentioned above. By activity, 392,000 (8.2%) were engaged in basic research, 615,000 (12.8%) in applied research, and 3,794,000 (79%) in experimental development. The number and proportion of R&D personnel engaged in basic research; applied research; and experimental development in higher education institutions, scientific research institutions, and enterprises are shown in the following table[177]. The figures in this personnel analysis indicate that a high proportion of basic R&D personnel are affiliated with institutions of higher education.

Table 2: Number of research and development personnel by institutional affiliation

(Unit: 10,000 person-years)	Nationwide	Private enterprises	Scientific research institutions	Higher education institutions	Others
Basic research	39.2	1.2	92	26.7	2.2
Applied research	61.5	14.3	14.8	25.8	6.6
Experimental development	379.4	351.4	184	4.1	5.5
Total number	480.1	366.8	42.5	56.6	14.2

(Same as above)

175 The Indicators of Science and Technology provide statistics for China by industry, government and university institutions, researchers, and other categories but do not provide information on their sources, so it is not possible to trace them back to the original sources.

176 JST Science Portal China Pekin Tayori, August 12, 2021 [21-043] "Analysis of R&D Personnel in China in 2019," JST Beijing Office, https://spc.jst.go.jp/ experiences/beijing/bj21_043.html (accessed December 7, 2021)

177 *Ibid.*

Based on this table, it appears that the percentage of R&D personnel engaged in basic research at higher education institutions is about 47%. However, while Table 2 above and Table 3 below show the same number of R&D personnel, the proportions of personnel employed in higher education institutions do not match.

Table 3: Percentage of research and development personnel by institutional affiliation (2019)

	Affiliated with universities	Affiliated with research institutions	Affiliated with enterprises
Basic research	68.1%	23.5%	3.1%
Applied research	42.0%	24.1%	23.4%
Experimental development	1.1%	4.8%	92.6%

(Source: Based on "2019 Analysis of Our Country's R&D Personnel Development Status" by the Ministry of Science and Technology of China [MOST][178])

As mentioned above, the figures in Tables 2 and 3 are not researchers but R&D personnel. The above personnel analysis indicates that in 2019, the number of researchers was 2,109,000, that is, 243,000 more than the previous year. This is consistent with the increase from the 1,866,000 (2018) mentioned above. Therefore, researchers are 43.9% of total R&D personnel. Based on these figures, the number and proportion of researchers in higher education institutions should be as follows. By analogy with the Indicators of Science and Technology (2020 edition), the proportion of researchers at higher education institutions should be about 19% (2018). Based on the total number of researchers of 2,109,000 (2019), the number of researchers at higher education institutions is estimated to be about 400,000. However, the 2019 edition of the China Statistical Yearbook of Science and Technology states that there were 4,381,400 R&D personnel in 2018, of which 305,000 engaged in basic research, including 191,300 at higher education institutions (see table below). The number of researchers at higher education institutions is estimated to be equivalent to 352,800 person-years. This is less than the total number of R&D personnel, which is equivalent to 410,900 person-years. Based on the proportion of personnel engaged in basic research at higher education institutions, 188,000 would be a reasonable estimate of the number of researchers engaged in basic research. The 2019 figures also confirm that approximately 190,000 researchers were engaged in basic research. Although the figures are estimated from different fiscal years and there is a difference between researchers and R&D personnel, the number of basic researchers in Chinese higher education institutions can be estimated by analogy, and approximately 41% of these researchers are exclusively dedicated to basic research. This indicates that, just as the ratio of basic research funds to total research funds in higher education institutions is not very high, neither is the number of researchers.

Incidentally, the number of foreign personnel working in China on a long-term basis is estimated to exceed 330,000, with over 8,300 young researchers accepted and 180,000 trained under the framework of the Belt and Road

178 Science Portal China, Pekin Tayori [21-043] Analysis of R&D Personnel in China in 2019, JST Beijing Office, August 02, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_043.html (accessed May 29, 2022)

Initiative.[179]

Table 4: Number of R&D personnel by implementing institution, 2018 (unit: 10,000 person-years)

	R&D personnel	Research personnel	Basic research	Applied research	Experimental development
Total	438.14	186.61	30.5	53.88	353.77
Private enterprises	342.48	114.32	0.92	12.9	328.66
Scienctific research institutions	41.3	29.46	8.5	14.75	18.05
Higher education institutions	41.09	35.28	19.13	19.69	2.27
Other	13.28	7.54	1.94	6.54	4.8

(Source: Prepared by the authors based on the 2019 edition of the China Statistical Yearbook of Science and Technology)

3.3 Chinese researchers' perceptions of basic research

We have looked at the definition of basic research in China, the evolution of policies related to its promotion, and the status of investment in basic research. We will now consider how researchers in China perceive the current situation of basic research.

First of all, assuming that the statistical methods described above are correct, the amount of investment in basic research in China is considerably lower than in Japan, the U.S., and Europe. We will now consider Chinese researchers' views on the amount of investment in basic research.

According to a paper by Xue Shu, Zhang Wenxia, and He Guangxi[180], published on November 13, 2021, the perception of research funding by basic researchers is as follows. In the "Survey of Science and Technology Personnel" conducted in 2020, 25.6% of basic researchers reported that they do not have enough funding for their research activities, 20.6% said they have very limited funding, and 11.3% said they have no funding at all. In the 2019 "Survey of Basic Research Personnel," 83.5% of basic researchers reported that they have difficulty obtaining research funding, 74.9% said that they lack stable research funding support, and 49.3% said that they spend considerable time trying to obtain stable research funding support. In a survey on research time, 68.9% of respondents reported that their research time was limited by meetings, survey, and administrative tasks. In the 2020 "Survey on Researcher Motivation and Perceptions," 67.2% of basic researchers said they were exhausted by dealing with funding audits.

The analysis suggests that under these circumstances, Chinese researchers tend to lose enthusiasm for long-term, time-consuming research and turn toward short-term studies on popular topics that yield easy results.

179 [21-036] Ministry of Science and Technology, "Commitment to Providing an 'Ideal Habitat' for Innovation Talent from All Over the World," Pekin Tayori, May 11, 2021, JST Beijing Office, https://spc.jst.go.jp/experiences/beijing/bj21_036.html (accessed December 18, 2021)

180 Xue Shu, Zhang Wenxia, and He Guangxi, "从科研人员角度看当前我国基础研究存在的问题," Science and Technology in China, edited by the Chinese Academy of Science and Technology for Development, Ministry of Science and Technology https://www.163.com/dy/article/GOLNMALU0514R8DE.html (accessed December 5, 2021)

Moreover, 37% of basic researchers no longer want to engage in basic research, preferring to turn to applied research or entrepreneurship. This will have a negative impact on the development of young researchers in the future. Furthermore, in the selection of university majors, there is a strong tendency to concentrate on the fields of computer science, business management, and finance and less interest in fields such as chemistry and mathematics.

The abovementioned policy documents on science and technology evaluation emphasize metrics related to the volume of publications and short-term achievements, making it difficult for researchers to focus on free exploratory research[181]. In other words, the type and number of papers, as well as the level of scientific research projects and the amount of research funding, are subjects of evaluation. In a survey of young personnel involved in basic research, only 41.6% reported that their institutions adopt the approach of evaluating "representative" papers, as per the direction set by reforms on papers, and 13.5% reported that their institutions rely on the system of small peer review by journals. With regard to evaluation, many institutions are evaluated on a cycle of one year or less, and less than 20% are evaluated on a cycle of two years or more[182]. It is said that under such "evaluation pressure," young researchers in particular are reluctant to engage in time-consuming and uncertain basic research, especially free exploratory research. Instead, they tend to pursue hot topics that produce immediate results in quick and easy short-term projects.

The same paper touches on the salaries of basic researchers. Salary levels are generally low, with 48% of basic researchers complaining of low salaries. This may be why 38.2% of scientific workers surveyed by CAST in 2020 said that the current "academic style" is "hasty, success-driven, and profit-driven" and that there is not a strong sense of "academic democracy." There are also researchers who try to profit by making exaggerated claims and prematurely selling their research results to the mass media, which makes it difficult for them to work steadily on basic research.

The following policies have been proposed to address this situation.

First, financial resources should be diversified, and investment and conditions for basic research should be enhanced.

In particular, investment in basic research from local governments and enterprises should be strengthened. Also, drawing on the experience of the joint fund model, local governments and state-owned enterprises should support basic research using the joint investment model, with the participation of private enterprises and foreign firms. In other words, enterprises and basic research institutions should collaborate to conduct basic research.

Second, investment mechanisms for basic research should be optimized by increasing the portion of stable funding and support for young researchers. In particular, investment in basic research as research without a specific topic should be increased. The timeframe and cycle for investing in basic research should be lengthened, and ongoing financial support for outstanding projects, especially for young researchers, should be increased. The acceptance rate of research projects led by young researchers should be increased as well. This measure should also include a reform of evaluation mechanisms for unpopular research fields and projects.

Third, science and technology evaluation policies should be reformed, and the evaluation cycle for basic research should be lengthened. The evaluation system should contribute to encouraging original innovation. To promote a long-term evaluation cycle for basic research, the personnel evaluation cycle should be three to five years, and mechanisms should be developed to recognize mavericks who are making headway in particular fields. Peer review should be

181 *Ibid.*

182 According to the above paper, 74% of the institutions reported that they conduct annual evaluations and 7.4% that they conduct evaluations every 6 months or less.

conducted on a smaller scale using an international, double-blind peer review method and evaluating representative studies.

Fourth, salaries for basic R&D personnel should be improved, and the fixed salary portion should be increased. According to the above incentive survey, 70% of researchers between the ages of 30 and 40 are expected to receive a salary of up to CNY 400,000, whereas the actual salary they receive from their institutions is up to CNY 200,000 per year. Therefore, while raising salaries as a whole, reliance on fixed salaries should be increased, and reliance on income from competitive funding should be reduced. Moreover, the portion of performance-based salaries based on operations should be increased, and the portion linked to short-term results should be reduced. This would increase the overall level and competitiveness of salaries for basic researchers compared to other researcher posts, while financially guaranteeing a higher level of pay. This would allow young researchers to earn a reasonable salary while also solving the housing problem; it would also allow researchers to engage in basic research with ease, without having to change jobs in search of a higher salary.

Fifth, scientific research management should be optimized, academic style building should be strengthened, and the research environment should be improved. This will include distinguishing basic research from other research projects, further optimizing the process of managing basic research projects, simplifying procedures, giving researchers more independence, reducing the time and energy devoted to project management and use of funds, and empowering researchers to engage in more scientific activities. At the same time, oversight of project funding should be strengthened to ensure standardization in the use of research funds and reduce risks in the use research funds owing to longer evaluations cycles. Regarding academic style and environment, governance mechanisms must be improved, placing greater emphasis on the autonomy of researchers and the capacity for independent self-governance of the scientific community and scientific organizations. There is also a need to strengthen education and training on the spirit of scientists and academic culture and to create a scientific research environment that encourages innovation, tolerance for failure, and dedication to research.

Although these proposals based on researchers' perceptions include some of the content already presented in the successive policy documents, they are noteworthy because they represent the real voices of researchers on the state of basic research and suggest directions for further reform in the future.

In FY2020, the JST China Research and Sakura Science Center (CRSC) conducted an investigation on the "Current Status and Trends of PhD and Postdoctoral Programs in China." The investigation included an interesting questionnaire survey on the "Current status and challenges of the development of young researchers" conducted with Tsinghua University, Peking University, Beihang University, and Beijing University of Chemical Technology. We will use some of the results of the survey to explore Chinese researchers' perceptions of basic research[183].

The survey began with a general question: "Are policies being implemented to concentrate funding only on research that is likely to yield results?" The following responses were received from researchers at major universities.

[Tsinghua University] This phenomenon still exists, but it is also related to the current evaluation system. The evaluation of R&D results is conducted on a relatively small scale, both in terms of time and space, and there is no way to evaluate R&D personnel and results from multiple perspectives. Many of the evaluations at this stage are simple

183 Japan Science and Technology Agency, China Research and Sakura Science Center, "Current Status and Trends of PhD and Postdoctoral Programs in China," March 2021, https://spc.jst.go.jp/investigation/downloads/r_2020_01.pdf (accessed June 5, 2021)

quantitative index evaluations, which do not give R&D personnel enough space or time to think and accomplish innovation. Rushing to make a profit is a universal phenomenon.

[Peking University] This kind of phenomenon exists in China, but it is not caused by policy. It is mainly due to micro factors such as sources of funds and evaluation systems for the use of funds. In terms of policy, the country places relatively high emphasis on basic science and technology and R&D, with policies such as “Made in China 2025” highlighting the importance of basic research. Part of R&D funding comes from commercial banks and enterprises, and the constraints of the demand for more efficient short-term use of funds have led to the emergence of an obsession with short-term results in related projects.

[Beihang University] This tendency is particularly pronounced in China. Significant research results begin with experimental exploration and generate economic returns, but they must take several steps from basic research to applied research, technology development, and product production, which may require a decade or more. However, looking at the current situation in China, partly due to national policies and unforeseen incidents (for example, the case involving Huawei Technologies), as well as the presence of speculative funds, industry is shifting into overdrive and investors are rushing to make a profit.

[Beijing University of Chemical Technology] That tendency certainly exists. The resources devoted to basic research are still inadequate. Enterprises should also be encouraged to invest in R&D. More policies and support for tax breaks and subsidies for basic research must be adopted as well.

Next, in relation to the above question, the respondents were asked, “Is China also a country where a short-term results-oriented approach is prevalent, and funding is only given to research that is likely to find immediate answers?” The responses are presented below.

[Tsinghua University] This problem is becoming more pronounced in China as well. China, in particular, adopts “Five-Year Plans” and is supposed to pursue several new directions and challenges every five years. Funding also depends on the Five-Year Plan. We could say that a short-term oriented and policy-driven approach is prevalent.

[Peking University] During the era of the planned economy, it was common for funds to be distributed widely. In addition to the problem of a general shortage of funds, the review system was not strict enough. Currently, the situation is the same as in Japan, moving toward one extreme, with the values of market economy having an excessive influence on scientific research, and short-term indicators such as short-term return on investment, economic efficiency of fund management, and so on, playing a dominant role. Although the absolute amounts have been raised to some extent, there is a keen awareness of the need to achieve quick results. Scientific research must be conducted gradually over time and must be balanced with reviews that motivate researchers.

[Beihang University] In Japan, the lifetime employment and seniority system has created a stable R&D environment. In China, after the economic bubble, an increasing proportion of funds came from direct market acquisitions, which became oriented toward efficiency in the use of funds and short-term profit, putting pressure on the duration and stability of R&D. R&D funding in China is based on a review and approval system, which is primarily policy-driven and generally considers the short-, medium-, and even long-term allocation of funds. However, owing to inadequate supervision and management, there are significant problems in the efficiency of the use of funds and the rationality of the R&D projects themselves.

[Beijing University of Chemical Technology] While funds for literature and history are distributed widely, R&D funds for science and engineering are the same as in Japan, with the problem that efficiency is prioritized, and results are demanded in the short term. In addition, the accumulation and succession of R&D by institutions have become weak points and are not being used for the long-term development of R&D. In particular, the development of basic research is not being utilized.

In general, there are doubts as to whether answers from researchers so closely involved to the field can reflect the situation as it actually is. In any case, the above answers are summarized below. Although the CPC Central Committee, the State Council, and the Ministry of Science and Technology have taken the lead in promoting basic research and have implemented various measures, basic research activities that require long-term efforts leading to significant discoveries are not always guaranteed and implemented owing to the pursuit of short-term results. Alternatively, researchers and research institutions may expect to receive more freedom to pursue their ideas and stable long-term support.

CAS academician Yuan Ya-xiang[184] expressed an interesting opinion about the “Current Status and Challenges of Developing Young Researchers” in China on the CAS website on March 21, 2021[185]. According to Yuan Ya-xiang, measures related to the development of young researchers have been expanded, mainly through NSFC funding. Development systems have been established, including the National Science Fund for Distinguished Young Scholars and the Excellent Young Scientists Fund. The young researchers who receive this kind of support gain certain “qualifications” and are further developed as researchers. However, the issue is how to support researchers before they obtain such qualifications, at the stage of research training (this stage is also called “threshold”). Yuan Ya-xiang further notes that academic disciplines have become increasingly fragmented, student specialization has become extremely narrow, and universities have become less fluid in their attempts to retain the best students within their ranks. While it is good that outstanding students are moving abroad for study in a world that requires greater mobility, it is worrisome that this is not fostering the development of young researchers in universities and scientific research institutions within China. Yuan is concerned that the belief that personnel can be easily recruited from foreign universities and research institutions, which has emerged in China, may discourage the development of independent measures for fostering young researchers within the country. In other words, Yuan laments the current situation in which the development of young researchers is heavily dependent on foreign countries. He concludes that it is necessary to establish an evaluation system that allows young researchers from China and abroad to compete fairly, and to that end, it is important to develop a system to foster and support young researchers in China.

The total number of doctoral students enrolled in PhD programs at U.S. universities was 62,578 in 2019, and foreign doctoral students rose to 42% of the total. According to reports to date, 75% of U.S. doctoral graduates stay in the U.S. for at least 10 years after graduation[186]. A study comparing the number of PhD graduates in STEM education at U.S. and Chinese universities shows that the China surpassed the U.S. in 2007, and by 2025, it will produce nearly twice as many STEM PhD graduates as the U.S., including foreigners (although the quality of education is an issue as well)[187] .

The trend of Chinese students pursuing doctoral programs in the U.S. and other foreign countries deserves attention

184 Yuan Ya-xiang: Member of the Chinese Academy of Sciences; Corresponding member of the Brazilian Academy of Sciences; Member of the China Development Institute; President of the Society for Industrial and Applied Mathematics; Vice Chairman of the 9th National Committee on Science and Technology Industry

185 Yuan Ya-xiang, 青年科研人才培养如何强起来, https://www.cas.cn/zjs/202103/t20210322_4781692.shtml (accessed December 5, 2021)

186 Remco Zwetsloot, Jack Corrigan, Emily Weinstein, Dahlia Peterson, Diana Gehlhaus Ryan Fedasiuk, CSET Data Brief “China is Fast Outpacing U.S. STEM PhD Growth”, August 2021, https://cset.georgetown.edu/publication/china-is-fast-outpacing-u-s-stem-phd-growth/#:~:text=Since%20the%20mid%2D2000s%2C%20China,future%20competitiveness%20in%20STEM%20fields (accessed January 5, 2022)

187 Remco Zwetsloot, Jack Corrigan, Emily Weinstein, Dahlia Peterson, Diana Gehlhaus Ryan Fedasiuk, *ibid.*

in the long term. However, looking at the actual number of Chinese students studying abroad to date[188], in 2000, there were 38,989 students leaving China and 9,121 students returning to China, with a low percentage of returnees (about 23%). In contrast, in 2017, 608,300 students left China to study abroad and 480,900 (about 80%) returned to China. The fact that the rate of returnees has gradually increased during this period may indicate that the duration of stay has become much shorter, although questions remain as to how to account for the existing time lag. In fact, for the 2020/21 academic year, the number of Chinese international students enrolled in the U.S. programs (including optional practical training or OPT) remained higher than any other nationality with 317,299 students, or 35% of the total. However, the trend was down 14.9% from the previous year. Despite the impact of the recent COVID-19 pandemic, the overall number of international students in the U.S. has plateaued at about 1.09 million since 2018/19[189]. Future trends will be closely observed.

As mentioned above, some believe that China lacks measures for developing young researchers and that its policy to foster young researchers relies on foreign countries, especially the United States. If the number of international students and researchers is decreasing, and the duration of their stay abroad is shortening, as described above, that means that the policy of fostering young researchers who are dependent on foreign countries, which has been criticized here, is itself becoming an Achilles' heel. There are concerns that in the future, researchers may have to continue their research careers in mainland China as they develop sufficient research skills and abilities by attending short-term study abroad or research student programs and may be unable to establish or maintain networks with foreign researchers.

Let us look at the actual state of basic research-related departments at universities. In September 2017, China introduced a priority policy by announcing first-class universities and disciplines, together known as "Double First-Class" and designated 42 universities and 465 disciplines. Aside from the universities, with regard to disciplines, the policy is very clear about which ones should be prioritized. Out of 463 disciplines, excluding so-called liberal arts subjects such as law and economics, about 380, or 82%, can be considered scientific disciplines, of which about 134, or 35%, include the term "engineering." This means that one third of the disciplines are in the science field, with an emphasis on engineering.

According to a study by Futao Huang (professor at the Research Institute for Higher Education, Hiroshima University), which surveyed 1,285 foreign researchers in Japan, researchers from China topped the list with 22%, followed by the U.S. (19%), South Korea (13%), and the U.K. (8%). Additionally, many Chinese researchers have engineering specialties[190]. As expected, there is a pattern of researchers from China coming to Japan to learn Japanese technology.

The degree of emphasis a country places on the promotion of science and technology, especially basic research, is

188 "Returning Scientists and the Emergence of China's Science System", Forthcoming, Science and Public Policy Journal, 5 December 2019 :Cong Cao, Faculty of Business, The University of Nottingham Ningbo China, Jeroen Baas, Elsevier B.V. Registered Office, Caroline S. Wagner, John Glenn College of Public Affairs, The Ohio State University, Koen Jonkers, European Commission, Joint Research Centre https://academic.oup.com/spp/article/47/2/172/5658550 (accessed December 16, 2021)

189 Opendoors, Institute of International Education (IIE), https://opendoorsdata.org/(accessed January 9, 2022). Incidentally, the number of international student enrollments (including OPT) from China to the United States was 369,548 in 2018/19, up 1.7% from the previous year, and 372,532 in 2019/20, up 0.8%. In addition, the total number of international students as reported by the Chinese Ministry of Education has increased to 662,100 in 2018 and 703,500 in 2019 (http://www.moe.gov.cn/).

190 Joyce Lau, "Chinese researchers now largest overseas cohort in Japan," June 1, 2021, https://www.timeshighereducation.com/news/chinese-researchers-now-largest-overseas-cohort-japan (accessed July 2, 2021)

also reflected in its award system. The highest award system in China is the State Science and Technology Award. The FY2020 National Science and Technology Awards were announced on November 3, 2021[191]. The fact that the National Science and Technology Award was given to researchers involved in nuclear energy, including the development of a high-temperature gas-cooled reactor, is a difference between Japan and China. However, that year, the award rate was reduced to 14.9% of nominees to enforce a policy of more strict evaluation of the relationship between achievements and awards. In particular, the number of nominees selected for the Special Prize and the General Prize of the State Scientific and Technological Progress Award reportedly decreased by 20%, and the selection process for the awards became stricter. Furthermore, the FY2020 awards were characterized by the continued encouragement of basic research, the importance placed on the application of research results, the selection of five projects involving foreign participants for the State Natural Science Award and other prizes, and the emphasis on international scientific and technological cooperation, with more than half of the projects awarded the State Scientific and Technological Progress Award being applied to the Belt and Road Initiative. Incidentally, Professor Fujishima Akira of the University of Tokyo was a Japanese recipient of the award.

3.4 Foreign perceptions of Chinese basic research

In terms of foreign perceptions, we will discuss the views on Chinese basic research expressed in some articles published in foreign journals such as *Nature*.

First, we will discuss an article published in *Nature* around 2010, just before the 12th Five-Year Plan, as one of the perceptions at that time. In the article “Publish or perish in China” dated January 12, 2010[192], the author discusses the fabrication of papers by well-known researchers, which was very frequent at the time, and mentions the seriousness of China’s efforts to deal with this problem. She also points to issues with the current situation in which counting the number of papers is the norm and suggests that this is due to bureaucratic interference in academic activities. In the 2010s, the number of Chinese papers grew at such a rate that it caught up with and surpassed the United States. However, the problems of evaluation that emphasizes the number of papers and of bureaucratic interference, which was seen as the cause of this type of evaluation, were clearly recognized even then. In fact, this drive to produce more and more papers has much in common with the reality of production sites where production is increased even as the inventory continues to accumulate in countries with planned economies[193]. The fact that the problem of research misconduct, including paper fabrication, has not been easily resolved has been addressed frequently since then, as highlighted in a *Nature* article that discussed the strengthening of countermeasures in China in 2018[194]. These discussions will not be repeated here.

Second, on June 22, 2016, just prior to the 13th Five-Year Plan, *Nature* published an article entitled “Policy: Boost

191 [21-055] China Announces FY2020 National Science and Technology Awards - International Science and Technology Cooperation Also Emphasized, Pekin Tayori, JST Beijing Office, November 15, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_055. html (accessed January 2, 2022)

192 Jane Qiu, “Publish or perish in China,” Nature, 463, 142 (2010) https://www.nature.com/articles/463142a (accessed June 7, 2021)

193 “The reason why there is so much excess production is that in socialist countries, enterprises are evaluated by their production volume, so they keep increasing their production volume.” Niwa Uichiro, “China’s Big Problem,” PHP Shinsho, p. 64.

194 David Cyranoski, “China introduces sweeping reforms to crack down on academic misconduct,” Nature, 558, 171 (2018), https://www.nature.com/ articles/d41586-018-05359-8, (accessed June 7, 2021).

basic research in China," which discusses Chinese basic research[195]. According to the article, Chinese researchers are focusing on increasing the number of papers, creating "paper mills." This is because of the rise in investment by the NSFC, which has increased more than 300-fold since its establishment in 1986, reaching CNY 24.8 billion in 2016 (contributing to 62.1% of Chinese researchers' papers). However, the amount of investment in interdisciplinary teams is low for regional universities compared to universities that can form such teams with a competitive edge, such as Tsinghua University. This distortion in the organization of interdisciplinary research is problematic. The article also states that it is important to rethink the evaluation system to place more emphasis on the impact of papers. Moreover, it is stated that emphasis should be shifted to the substance of academic merit rather than short-term goals. As indicated by the answers to the questions in the questionnaire survey above, this suggests that an appropriate balance should be struck with respect to investments in basic research. Above all, the article states the need to set high standards for the quality of papers. In summary, four issues are raised. First, researchers should be encouraged, rather than discouraged, to make scientific breakthroughs; second, evaluation strategies should be adopted to assess merit using appropriate metrics; third, a "sound, comfortable academic environment" should be created where researchers can focus on their research, free from mundane tasks, and devote their energies to grant execution without worrying about criticism; finally, a Chinese business model should be devised to identify and develop applicable research results.

The above are views on basic research in China that were submitted to *Nature* before the 13th Five-Year Plan. The focus is on the problem that researchers are under pressure to produce more papers, do not have a culture that values quality, and are too busy with other tasks to concentrate on research and, therefore, cannot produce results that lead to innovation. *Nature* has often reported on the high level of paper fraud in China since the 2000s but has also noted that such fraud decreased considerably in the 2010s.

In January 2018, the Chinese government released the "Opinions of the State Council on the overall strengthening of basic scientific research," a guidance document that spurred a series of measures to promote basic research. The *National Science Review*, in its article entitled "Advancing basic research towards making China a world leader in science and technology," touched on China's steady progress up to that point and reported on its policy of expanding basic research that leads to innovation, centered on "State Key Laboratories[196]." The article describes China's various reforms but also points out that the amount of investment in basic research in China remains low, especially from the corporate side, and that basic research has not yet reached the point where it provides the fundamental technology for industry. In terms of human resource development and research environment, the article presents several important points: academic independence; support for long-term, high-risk research; and an emphasis on the quality, rather than the quantity, of research papers.

However, these points are not unknown to the Chinese government. The issue we need to examine is whether or not the policies that China is trying to implement based on the recognition of these various aspects are appropriate for the promotion of basic research.

Now, let us look at what changed in the content of *Nature* articles in March 2021, just after the 13th Five-Year Plan ended and the 14th Five-Year Plan was issued.

[195] Wei Yang, "Policy: Boost basic research in China," Nature, 534, 22 June 2016, pp. 467-469, https://www.nature.com/articles/534467a (accessed June 6, 2021)

[196] Wei Huang, "Advancing basic research towards making China a world leader in science and technology," National Science Review, volume 5, Issue 2, March 2018, pages 126-128, https://academic.oup.com/nsr/article/5/2/126/4816745 (accessed June 7, 2021)

We will discuss the March 11, 2021, article entitled "China's five-year plan focuses on scientific self-reliance[197]." The article recognizes that the recent U.S.-China conflict has been a "wake-up call" of sorts for China, which is moving toward greater independence in the areas in which it excels. The analysis notes that this means moving basic science toward more socially important fields, as Chinese researchers face increasing difficulty in networking with their U.S. counterparts. This, in turn, means that research and industry will be closer together, with private enterprises investing more in basic science and industry placing more emphasis on involving researchers at scientific research institutions to apply the results of basic research to the real world[198]. The shift of emphasis to industry is expected to lead to a change in the evaluation method to one based on impact rather than number of papers. The article states that China is expected to increase its R&D investment at a rate of 7% per year in the future and to increase its basic research investment by 10.6% in 2021. China is on track to achieve the goal of 8% of R&D investment in basic research in 2021, which is the goal of the 14th Five-Year Plan.

Nature, as of March 2021, still sees China as planning and executing a linear model from basic research to innovation, that is, to social and economic applications. The U.S.-China conflict is expected to further strengthen China's path to self-reliance in utilizing the results of its own basic research.

Nature, a fairly mainstream journal, is quite restrained in its tone. Nevertheless, it repeatedly addresses the issue of research integrity, which is not easily resolved, and expresses concerns about the reality of China's emphasis on the number of research papers. Meanwhile, blogs in general present a rather harsh and stark view of the situation. An example is given below. In September 2020, ChinaTalk[199] published an article lamenting China's biased evaluation of the number of research papers and its methods for the review of grants. This article discusses a culture that is sensitive to hot topics that are attracting attention in global research and that pushes for more research that closely imitates works on those topics (known as "punch-in research," a term from the recording industry that denotes "research that supplements or modifies part of a previous study") and divides the results into smaller pieces to increase the number of publications (a practice known as "salami-slicing"). In addition, the article states that neglect of original research topics is rampant, and research requiring a long period of time is disregarded, making it difficult to continue research that does not produce papers, and forcing researchers to leave research institutions. The article illustrates how young researchers are trained in such an environment and eventually become part of the leadership, making reform increasingly difficult. Even if this phenomenon has been reduced to some extent, it probably reflects a certain reality.

The above articles were written before the announcement of the 14th Five-Year Plan. Whether or not they lead to any general conclusions, the points made in *Nature* and elsewhere imply the limitations and rigidity of Chinese society, which aims to perfect a socialist market economy under the leadership of the CPC Central Committee and where the idea of planning and unified leadership has expanded to policies to promote basic research and to link the results of such research to innovation. This also raises the question of whether such a thing is humanly possible and whether scientists and researchers can develop creative activities under such guidance. It will be interesting to see

197 Smriti Mallapaty, "China's five-year plan focuses on scientific self-reliance," Nature, 11 March 2021, https://www.nature.com/ articles/d41586-021-00638-3 (accessed 6 June 2021)

198 According to the above article, in December 2019, the Ministry of Human Resources and Social Security made it possible for researchers at scientific research institutes to take a six-year sabbatical to create a start-up. During this period, researchers will enjoy promotions and other benefits, and their achievements will be properly evaluated.

199 Jordan Schneider, "Why Chinese Basic Research is Failing," China Talk, September 9, 2020, https://chinatalk.substack.com/p/why-chinese-basic-research-is-failing (accessed June 10, 2020)

how the 14th Five-Year Plan will be implemented and whether or not basic research will actually produce a clear improvement in the quality of papers.

4 China's Scientific Journals, Publication Databases, and Scientific Papers

It has been noted in many sources that China's scientific papers have developed dramatically over the past 20 years or so, both in terms of quantity and quality. We will look at Chinese scientific papers in more detail later in this chapter, but first we will introduce the state of the scientific or academic journals in which papers are published and the challenges they face. This is also an important issue closely related to the promotion of basic research.

As shown in section 4.2, China is steering away from evaluating the number of papers in research grant reviews, awards, and so on to placing more emphasis on their quality. However, it is crucial to know how the journals themselves are run in the first place. Opportunities to learn about the Chinese journal system are limited. Here, the system will be described based on an article entitled "The Chinese scientific publication system: Specific features, specific challenges," written by Jing Wang et al. of the Institute for Science in Society, Radboud University, the Netherlands, and published in Learned Publishing[200].

It should be premised that although the paper by Wang et al. points out problems with the Chinese scientific publication system, it also highlights common international challenges that journals around the world face and need to resolve. However, it is considered a valuable source of information on China's little-known scientific publication system.

4.1. Chinese journals

4.1.1 The highly controlled establishment and operation of Chinese journals

First of all, the Chinese media and publishing world in general are characterized by a top-down management approach, with Chinese journals under the control of national and local authorities and a high degree of control over the establishment and operation of journals.

First, the establishment of a journal requires a national license, which must be obtained by meeting strict requirements and being approved by various administrative authorities. Upon receiving the establishment license, a China Number (CN) is issued by the General Administration of Press and Publication (GAPP, in Chinese 中华人民共和国新闻出版总署). Thereafter, an International Standard Serial Number (ISSN) is assigned, and publication can commence. The establishment of a journal requires the involvement of three organizations: an "authority" such as the competent ministry; a "sponsor" such as the university or scientific research institution to which the journal belongs that provides financial support; and a "publisher" that will publish the journal. These three parties are the owners of the journal. Journals with CN numbers are treated as Chinese journals, even if foreign publishers are involved in their

200 Jing Wang, Willem Halffman, Hub Zwart, "The Chinese scientific publication system: Specific features, specific challenges," Learned Publishing, 12 September 2020, https://onlinelibrary.wiley.com/doi/full/10.1002/leap.1326 (accessed June 15, 2021)

publication. It should be noted that the term “Chinese journals” by itself can have several interpretations, including international journals that have obtained CN numbers, Chinese journals published in Chinese, and Chinese-language journals that include abstracts in English.

The review process at the time of the journal’s establishment is extremely rigorous and usually involves three stages. The first is ideological censorship. Needless to say, the journal must be in line with the ideology of the state. After its establishment, it continues to be monitored for political correctness and published content. The second stage is the allocation of resources based on planned priorities. CN numbers are very limited, and journal licenses are granted according to a national planning model. The number and distribution of journal publishers is planned by the State Council for the entire country, which guides and coordinates the development of the publishing industry as a whole. In other words, a journal can only be launched if it is given a high national priority and commensurate resources are allocated. Third, the journal’s founders are evaluated on whether they have adequate financial support, a place to conduct operations, and competent editors. Usually, Chinese journals are considered social and public goods under a planned economy. Although some have the status of state-owned enterprises, they are mainly non-profit organizations that receive financial support from the state and are subject to state financial measures as a condition of their operation. The assurance of state financial support should have a fundamentally positive effect. However, in reality, the state’s involvement is formalistic and focused on ideological censorship, at the expense of ensuring the quality of the journal.

Another characteristic is that, in addition to the journal licensing system, administrative control is exercised through journal ownership and management. At the top level, there is GAPP, which oversees the journal, and at the bottom level, there is management of the journal’s operations through the involvement of the three organizations mentioned above. This multi-layered management system and hierarchy of authority over journals distinguishes the Chinese scientific journal publishing system from that of Western countries. The Western system usually consists of a commercial or academic publisher, an editorial office appointed by the publisher, and an editorial board represented by an editor-in-chief.

The top authorities are mainly government departments (ministries), scientific institutes, and scientific organizations; the sponsors are institutions affiliated with these authorities, such as universities under the Ministry of Education and professional associations under CAST; and the publishers are editorial offices, which are usually established under the sponsors’ supervision and are responsible for the daily operation of the journal. Publishers are not allowed to have private ownership of the journals (although some private participation is currently allowed). The GAPP rules clearly define responsibilities through this three-tier system, whereby the publisher clearly identifies authorities and responsible sponsors who have significant power over the management of the journal. The competent department has political oversight over the implementation of the policy and review of the contents of the publication. The sponsor is, from the publisher’s point of view, a direct superior and the entity that guarantees the necessary conditions for the establishment and financial security of the journal. The publisher, or editorial office, engages in the practical editorial procedures, that is, the selection, editing, and review process. The editorial office itself does not have the authority to appoint the editor-in-chief or select the editorial board members. After the reform of publishers in 2012, national organizations have been the primary shareholders, although some publishers have converted to corporations.

4.1.2 Journal publishers and number of publications

Thus, although the establishment and operation of journals are centrally managed, their implementation can vary widely. At the end of 2016, 5,020[201] 1,375 authorities and 3,232 sponsors managed journals. The top three of these authorities are CAST, the Ministry of Education, and CAS, which manage 459, 414, and 277 journals, respectively. However, there are only eight publishers that publish more than 10 journals each. The top two publishers are China Science Publishing & Media Ltd. and National Medical Journal Ltd., with 143 and 117 journals, respectively. The number of publishers that publish only one journal is 4,205 (about 85%). This is very different from the situation in the United States and Europe, where five companies publish 53% of all journals (the five companies include four privately owned companies: Reed-Elsevier, Wiley-Blackwell, Springer, and Taylor & Francis natural science and medical journals; and one non-profit organization, the American Chemical Society). Thus, Chinese journals are extremely decentralized, yet under public control.

4.1.3 Review process for manuscripts

Next, the abovementioned paper presents the editorial process of a Chinese journal. Manuscript review is a critical part of the academic publication process and is especially important to ensure the quality and integrity of published papers. Editorial evaluation, including peer review, has given rise to a series of operational innovations in international journal publishing, such as open review and post-publication review. Although the Chinese journal publishing system has a simplified structure with small editorial offices and few editors, international peer review has gradually become the mainstream in the evaluation of manuscripts in China since the 1990s. However, this is a rather unique system characterized by a unique tension. In particular, the Chinese peer review system is a form of "censorship of the press" introduced by modifying a three-tier review system that China originally imitated from the Soviet Union. In China today, this three-tier review system is used by all publishers of books and journals, with the first round of reviews being conducted by "editors," the second round by the "director of editors," and the final round by the "editor-in-chief" of the journal. By the 1990s, it was expected that Chinese journals would be internationalized, and peer review was one important criterion to determine whether internationalization had been accomplished. In other words, the question was how this three-tier review system was consistent with international review practices. In particular, the problem was achieving quality control comparable to the so-called Western format, which places more emphasis on reviews by experts in addition to editorial board members, and more emphasis on reviews by international experts than reviews by Chinese experts. China was reportedly concerned about the impact factor because it was unable to evaluate research projects and papers using the peer review method in the first place. In Europe and the U.S., there is the idea of using the impact factor as a reference while recognizing its pitfalls. However, this is possible only when the peer review system is established and functioning properly. One of the issues to be addressed in the future is the maturation and establishment of this peer review system when papers, that is, the quality of research, are subject to review.

International peer reviews were initially conducted at several Chinese universities. For example, the *Journal of*

[201] The number of journals published in China as a whole should be compared with other surveys and statistics. Incidentally, the figure of 5,020 journals was also reported in Science Portal China, "China's Science and Technology Journals Reach 5,020 Publications," dated January 31, 2018. https://spc.jst.go.jp/news/180105/topic_3_04.html (accessed August 15, 2021)

Zhejiang University Science introduced international peer review in January 2002, followed by *Tsinghua Science and Technology* and the *Chinese Journal of Oceanology and Limnology*. These journals attempted to introduce international peer review into the second of the abovementioned tiers, that is, the "editorial director" stage. This implied a change in the role of "editorial directors" (considered to be synonymous with "directors of editors" mentioned above), meaning that they were generally not from the same institution or the same country. To date, many Chinese English-language journals cooperate with major international publishers and share their publication processes. The internationalization of Chinese journals is expected to lead to the spread and establishment of a Western-like culture regarding peer review. However, these English-language journals represented only 6.7% of the journals published in mainland China through the end of 2018.

With regard to the peer review process, Chinese journals have gradually introduced anonymous reviews of manuscripts since 2000. According to a survey of 156 journals published in 2016, peer review was used in 148 journals (95.5%), of which 80 journals (54%) used double blind peer review and 42 journals (28.3%) used single blind peer review. These findings indicate that peer review is currently the dominant method for evaluating journal manuscripts in China. At the same time, electronic tools to aid in evaluation, such as plagiarism scanning and reference cross-checking, are being introduced. Still, some researchers have been critical of peer review in Chinese journals as only a partial reform of the three-tier review system and not truly independent peer review. Despite using the widely adopted international peer review process, as many sources warn, the current Chinese system does not always meet common academic standards. In the Chinese system, the details and criteria of the review process are less clear than in international journals. Elements of personal relationships, reviews by reviewers whose areas of expertise do not match that of the manuscript, and the lack of a rigorous review cycle were mentioned as differences between the international peer review process and the one used in China. Furthermore, according to a survey based on the reviewer database of the Society of China University Journals, 69.6% of reviewers have difficulty in determining the evaluation criteria for manuscript reviews. In addition, there have been conflicts between editors and authors owing to the long review cycle and insufficient communication regarding reviewers' expertise and competence. Editors tend to respect reviewers' opinions at the expense of the author's needs. Another problem with this system is that it lacks transparency. One scholar noted that the editorial offices of academic journals sometimes lack a transparent operation system for the selection and management of reviewers. The review process in China differs to some extent from the Western model. In particular, the editor-in-chief has a more prominent role than their peers, who are experts. For this reason, the review process is vulnerable to nepotism, for example. This lack of transparency is of particular concern in light of the system's origin as an instrument of political censorship. As a general rule, peer review is a process whereby submitted papers are evaluated based on standards of quality that are widely accepted in a specific research community. This means that a rejection or revision request is based on scholarly considerations, which sometimes enable and even require authors to improve their work. Furthermore, in the international research community, it is easier for researchers who are not satisfied with the existing review process to establish their own journals, unlike under the Chinese system.

In this context, there is a need for more empirical and in-depth theoretical research on peer review in Chinese journals. In fact, in light of changes in aspects such as the timing of reviews, the modes of interaction between authors, reviewers, and editors, as well as the development of assistive technologies, international peer review trends in the world, including China, should be closely observed.

4.1.4 Challenges in publishing Chinese journals: license system, government control, CN numbers, and peer review evaluation methods

As mentioned above, the paper by Wang et al. raises some issues with journals in China.

First of all, the journal licensing system described above is "insufficiently selective" to ensure the quality of journals. This licensing system, of course, grants permission to publish. However, without a process to exclude low-quality journals, it could also provide legal protection for "trash journals." In light of the demand for journal publishing, government financial support and licensing policies, it is conceivable that journal publishing could be viewed as a business opportunity without regard to the quality of the papers. Wang et al. point out that the way the country regulates this aspect may discourage the pursuit of rigorous research.

Second, there are flaws in the government's plan for the type and overall number of journals. Although the total number of Chinese-language journals is adequate, their composition is skewed, with a large number of "all-round scientific journals" and a relatively large number of Chinese-language scientific journals. Lack of specialization and clarity of focus means that the needs of new and particularly highly specialized fields cannot be met. This leads to the stifling of scientific innovation. Moreover, China is now planning to establish Chinese journals in English. Some scholars wonder whether the CN number system mentioned above will hinder this ambition. The official method of granting CN numbers is through the "Action Plan for the Excellence of Chinese STM Journals," which states that 10 journals per year will be licensed from 2013 to 2015, 20 journals per year from 2016 to 2018, and 30 journals per year from 2019 onward. This pace is not in line with the actual needs of the scientific field, which requires more than 1,000 journals in English. Flaws in the national plan include problems such as the lack of a balanced forum for interdisciplinary fields and the shortage of spaces to publish in view of rapidly growing research needs. In fact, looking at the 2018 Journal Impact Factor Quartile[202], Chinese journals are not ranked in the first or second quartile in 135 of the 240 research fields.

Third, regulations based on CN numbers do not adequately meet the growing publication needs of researchers. So far, both the promotion of researchers and the examination of PhDs have required the publication of a certain number of papers. Prior to the recently announced policy reforms, research careers in China had a research evaluation system that relied considerably on publications, that is, on quantitative publication criteria. The need to publish papers far exceeded the supply of state-controlled journals, leading to increased competition and pressure among researchers. This pressure contributed to the questionable practices of brokers selling papers and researchers buying authorship. Some actors even engaged in the illegal practice of using the same CN number for more than one journal. This approach increases the risk of a decline in the integrity of research and the quality of papers.

Fourth, the operational challenges of journals are presented. As mentioned above, journal owners are responsible for providing financial support under State control, which is an advantage. However, in practice, the complex and hierarchical management structure causes problems and creates a highly unstable and unfavorable situation for journals.

[202] Journals in different fields are compared through rankings and quartiles in each field.
The ranking of journals in their respective fields indicates which ones are more highly regarded. A journal ranked 25th out of 250 would be more highly regarded than one with the 25th best impact factor out of 50. A ranking of Q1 in the quartile of the field indicates that the journal is within the best 25% in its field (from Clarivate, https://support.clarivate.com/ScientificandAcademicResearch/s/article/000007519?language=ja [revision accessed June 16, 2021]).

Since 2012, the Central Office of the State Council has converted several state-owned publishers to state-owned enterprises to allow the market to play a more productive role and make publishers more market-oriented enterprises. However, this transformation has resulted in an incomplete and still bureaucratic way of operating today.

The immediate problem with this management approach is that there is no maneuvering space for the publisher. Journals are cross-managed by various departments, which poses a challenge to journal and editorial independence. In addition, journals' operating funds are dependent on government funding, and as a result of this management and financial arrangement, publishers do not have a clear sense of ownership. A publisher can receive financial support in a way that is independent of market competition, and this mechanism does not create incentives for publishers to innovate and lacks a sense of competition or initiative to improve services. This results in an inefficient and time-consuming review process for editorial offices. The hierarchical operation system regulated by the state lacks the role of the market in bringing about quality improvements. Improvements in journal quality are highly dependent on the personal efforts of editors, top-down pressure, or government policy, and journal quality varies considerably from one individual or editor to another.

Findings on editorial evaluation and peer review include the following. One study provides an overview of problems frequently experienced by Chinese researchers compared to international peer review. Responses to surveys, among other reports, cite long review cycles, unclear processes, and careless review comments as the main problems experienced by authors.

In sum, partly because of its peculiarities and complexities, the Chinese journal publishing system presents specific challenges for improving journal quality, especially in the context of new research evaluation policies and the trend toward open science.

First, as the policy shifts the evaluation criteria from quantity to quality, priority will be given to high-quality papers and high-quality national journals. This new policy has an impact on journal development in China, as it is expected that one third of papers by researchers belonging to Chinese institutions will be published in high-quality English-language journals in China (as per section 4.2, on February 20, 2020, the Ministry of Science and Technology announced[203] a list of 280 designated journals of excellence). This policy provides an excellent opportunity to improve Chinese journals and address the challenges of China's journal publishing system. The question remains as to whether journals will have enough capacity to develop higher quality papers and handle a growing number of papers.

In addition, new challenges are emerging in terms of new business strategies in the publishing industry. As noted above, Chinese journals clearly operate differently from international publishers. International publishers are supported by the scientific community, rather than by a centrally controlled management system. The advantages are a well-developed chain of production, a clear division of labor, and highly efficient and meticulous quality assurance procedures. In contrast, the state-controlled Chinese publishing system allows for coordinated efforts in the research system, where centrally controlled resources are a strength. Although Chinese publishers have shifted to a commercial model in an effort to improve their competitive position globally, they remain under a system of State control. Questions remain as to whether the business logic of international publishers can fit into the Chinese journal model.

If we measure the experience of China against the so-called Western system, we will find that there are flaws on

203 Ministry of Education, Ministry of Science and Technology 印发《关于规范高等学校SCI论文相关指标使用 树立正确评价导向的若干意见》的通知
http://www.moe.gov.cn/srcsite/A16/moe_784/202002/t20200223_423334.html (accessed June 17, 2020)

the Chinese side. There are many issues with journal ownership and the internationally mainstream practice of peer review itself. However, as mentioned earlier, the fact that the top five Western publishers publish a significant number of journals is problematic as well. Rather than advising China to adopt the Western model, the challenge would be to improve transparency and ensure fair access in the current global journal publishing system, taking into account the various approaches of different socioeconomic systems.

As discussed in section 4.2, China has launched an effort to refine and improve the quality of its journals, focusing on eliminating low-quality journals and providing public support for certain journals originating in China. In this context, journals such as *Genes & Diseases* and *Light: Science & Applications* are published in cooperation with international publishers. As briefly touched on above, we will now explore the internationalization of these Chinese journals, which are expanding on an international level.

4.1.5 Internationalization of Chinese journals

In 2020, there were 225 Chinese science and technology journals indexed in SCI, 17 more than in 2019. There were 229 Chinese journals indexed in Ei (Ei-Compendex), 136 indexed in Medline, and 2 indexed in SSCI (Social Sciences Citation Index). In 2020, 18 journals were ranked in the top 25% of their discipline for total citations, 2 more than in 2019, and 85 journals were ranked in the top 25% of their discipline for impact factor, 16 more than in 2019[204].

Genes & Diseases is an international journal selected through the "Action Plan" described in section 4.2. It is sponsored by Elsevier and run by seven related organizations, including the Ministry of Science and Technology and CAST, with article fees covered by Chongqing Medical University. *Light: Science & Applications* was founded in March 2012 by CAS's Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP; Chinese name: 长春光学精密机械与物理研究所), in partnership with Nature Publishing Group (NPG, now Springer Nature). *Light* was established with the intention of "creating a Chinese version of *Nature*" and is now "one of the top three optics journals in the world[205]." In only seven years, *Light* has become a leading international scientific journal with an impact factor of 14[206]. "Members of the *Light* editorial team regularly visit NPG headquarters each year for training, and editors from *Nature*, *Nature Photonics*, and other journals are invited to share their experiences and build *Light*'s international team. In addition, *Light* takes full advantage of NPG's network, submission, publication, language elaboration, and manuscript processing platforms, absorbing *Nature*'s best manuscript handling processes, processing norms, printing, artwork, and so on, to ensure that its content is of the highest quality[207]." About 70% of the journal is edited independently by editorial board members, who are reportedly leading researchers from the U.S. and Germany, whereas the Nature Group supports the printing and distribution of the journal as well as advertising

204 [22-007] "Summary of China Science and Technology Paper Statistics 2021 Release: Ranked 2nd in the World for the Number of Papers Published in Top World Journals," JST Pekin Tayori, JST Beijing Office, February 24, 2022, https://spc.jst.go.jp/ experiences/beijing/bj22_007.html (accessed March 7, 2022). In 2017, there were 173 Chinese science and technology journals indexed in SCI and 12 Chinese journals with impact factors in the top 25% of their respective fields, so these data show considerable progress.

205 Guo Chenzi (Deputy Editor-in-Chief, Light Academic Publishing Center, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences), Bai Yuhong (Director, Light Academic Publishing Center), "Researchers' Expectations for *Light*: *Science & Applications*," China Science and Technology Innovation Policy Commentary, February 20, 2020, Science Portal China, APRC/JST

206 5 Year Impact Factor: 15.005 (as of June 2021) https://www.nature.com/lsa/about (accessed June 27, 2021)

207 Guo Chenzi, Bai Yuehong, *op. cit.*

and other public relations activities. According to Zhou Shaodan[208], "In addition to borrowing the brand power of a world-renowned journal, [*Light*] receives more submissions from high-level researchers who regularly contribute to *Nature*. Through the powerful network of *Nature*, [*Light*] can also call for submissions and introduce the published papers to a wide range of well-known researchers around the world to increase citations." Moreover, according to Zhou, "A decade ago, there were no journals with an impact factor over 10 in China. Last year, however, there were four. All of them are characterized by a rapid increase in impact factor over the past few years, with some journals reaching an impact factor of more than 10 in just four years since their inception[209]." In November 2019, the Chinese publishing media company Science Press[210] also formed an international alliance by acquiring EDP (Edition Diffusion Press) Sciences[211], a renowned French journal publisher. EDP Sciences sees this alliance as an opportunity for further growth. In addition, an initiative has been launched to publish world-class journals in China, establishing new journals in collaboration with *Science* and *Nature* and evaluating and ranking journals. Noteworthy publications are said to include *Chinese Science Bulletin* and *Fundamental Research*, published by the NSFC, and *National Science Review*, a journal published by Oxford University Press of which CAS Director Bai is the editor-in-chief.

According to *The Scholarly Kitchen*[212], co-publishing is generally the first step in a process. It is followed, as a second step, by the creation of an international office such as PPM International, which was founded in London in 2012, and as a third step, by the execution of a merger and acquisition. The international expansion of Chinese journal publishers began with KeAI, a publishing service launched in 2013 in partnership with Elsevier. At that point, KeAI simply used Elsevier's digital platform, but over the next six years, it went on to publish more than 50 journals. The above case of EDP Sciences is considered to be the first time the process reached the third step, but it is actually not the first acquisition. The first acquisition was that of Canadian publisher B. C. Decker by People's Medical Publishing House[213] in 2008, and the second was that of Publications International, a U.S. children's book publisher, by Phoenix Publishing & Media Group[214] in 2014.

The case of EDP Sciences is seen as a model for the international expansion of Chinese journals, which is very

208 JST Fellow (at the time) interviewed in the NHK Science & Culture article mentioned in footnote 210.

209 "Taking the lead in scientific journals: Japan's response to China's new strategy," NHK Science & Culture, October 7, 2019. https://www.nhk.or.jp/d-navi/sci_cul/2019/10/story/story_191007/ (accessed June 26, 2020)

210 Science Press, which originated from Longmen Book Ltd., founded in the 1930s, is under the jurisdiction of the Chinese Academy of Sciences and publishes about 340 journals annually. Prominent Chinese scholars have contributed to its development, and since the 1970s it has had offices in the United States and Japan, and it has worked with over 200 publishers in more than 20 countries. EDP Sciences, "EDP Sciences joins forces with the Chinese Academy of Sciences and its publisher Science Press Ltd.," 19 November 2019, https://www.edpsciences.org/fr/actualites/1969-edp-sciences-joins-forces-with-chinese-academy-of-sciences-and-its-publisher-science-press-ltd (accessed June 26, 2020)

211 EDP Sciences is the publisher of French journals such as *La Société du Journal de Physique et Le Radium*, founded by Marie Curie and others in 1920. It has continued to publish journals under its existing editorial structure after the acquisition by Science Press. Science Press is a major journal publisher in China, majority owned by CAS, to which the Nobel Prize winner in Physiology or Medicine, Tu Youyou, also contributes (EDP Sciences, *op. cit.*). EDP Sciences appears to have been acquired by CSPM Europe, a subsidiary of Chinese Science Publishing and Media (CSPM), for EUR 12 million. This business model is said to have alleviated concerns about Chinese acquisition of journal publishers. In reality, this matter involves complex decision-making by China after the acquisition, but this has not been made clear in these negotiations.

212 Tao Tao, The Scholarly Kitchen, "Guest Post — The Emergence of Chinese STM Publishers: Threat or Opportunity? An Interview with Matthias Wahls," Nov. 19, 2019, https://scholarlykitchen.sspnet.org/2019/11/19/guest-post-the-emergence-of-chinese-stm-publishers-threat-or-opportunity-an-interview-with-matthias-wahls/ (June 26, 2021)

213 http://app.chinabookinternational.org/?app=press&controller=index&action=index_en&pressid=1584 (accessed June 26, 2021)

214 http://app.chinabookinternational.org/?app=press&controller=index&action=index_en&pressid=480 (accessed June 26, 2021)

much on the "strategic radar" of the Chinese government, as China aims to internationally expand its journals from a global perspective. Moreover, if Science Press can extract valuable international expertise through this acquisition, it could eventually become a truly international STM journal publisher. Although the focus is currently on submissions from China or from developing countries, the plan is probably to attract a wider range of submissions from developed countries.

On March 16, 2021, EDP Sciences published the "Blue Book on China's Scientific Journal Development 2020," a comprehensive overview of Chinese journals that is said to be the first guidebook to give an overview of Chinese STM journals in English[215].

4.1.6 New academic infrastructure pursued by China through the internationalization of journals

In the trend toward open science, large international publishers will continue to improve their services while encouraging open access and further positioning themselves as academic infrastructures for knowledge production, data storage, or research evaluation. Against this background, journals will develop not only as a tool for research publication but also as a platform for expanded research information. The key point is who will own these expanded journal platforms to further benefit knowledge production — the scientific community, the central government, or commercial publishers. In the current state of uncertainty, open science is both an opportunity and a challenge not only for China but also for transforming the state of academic journals worldwide. China's ongoing initiative is to build its own platform and specific infrastructure of scientific communication. The intent of this policy is not to give international publishers control over Chinese knowledge. However, this initiative is quite ambitious and challenging. Without long-term experimentation and significant investment, it will be impossible to create high-quality journals and academic infrastructure. Initiatives to build the new academic infrastructure mentioned above include the international expansion of China's domestic English-language journals and the promotion of submissions to Chinese English-language journals through open access, which China has already begun. The introduction of new research evaluation indicators may also free Chinese researchers from the "obsession[216]" with impact factor, a culture created by the United States, allowing them to focus on more creative activities. The four major publishers will face a shrinking market in China, although the burden on the authors will not be a problem since the funds will circulate within the country. Meanwhile, so-called Western publishers, represented by the four major publishers, will be unable to ignore the sheer volume of scientific production in China (more than 5,000 domestic Chinese journals and several hundred Chinese English-language journals) and will be increasingly forced to develop their own business.

215 EDP Sciences, "Blue Book on China's Scientific Journal Development 2020" - Key book and essential guide to STM publishing now available in English language, 16 March 2021, https://www.edpsciences.org/fr/actualites/2269-blue-book-on-china-s-scientific-journal-development-2020-key-book-and-essential-guide-to-stm-publishing-now-available-in-english-language (accessed June 26, 2021)

216 Tao Tao, *op. cit.*

4.1.7 Selected Chinese journals of excellence and their approach to finding publishing papers

JST Science Portal China's Science and Technology Topics provide information on what are probably the latest developments in Chinese journals. This information is found in the articles "Aiming for World-Class: Focusing on the Development of Chinese Science and Technology Journals (Part I)[217]" and "Publishing More First-Class Research Results: Focusing on the Development of Chinese Science and Technology Journals (Part II)[218]" from the June 23, 2021, edition of *Science and Technology Daily* by reporter Cao Xiuying. As noted above, China is attempting to realize a basic policy of publishing selected international journals domestically and also attracting papers from outstanding foreign researchers. To this end, China has also enlisted the help of international publishers and editors. It is interesting to read about how this was realized in these articles.

First, the articles discuss the brilliant results of several journals and their wide range of fields, from medical biology to physics and computer science. It is said that these journals are leading the way in the publication of these scientific results, both nationally and internationally. What is noteworthy is the method used for publishing papers that showcase these results. The approach found in several instances in the above articles is to have researchers who are considered to be doing excellent research write papers and have them published. We will quote a few passages below.

Launched in 2015, *Engineering* has seen its "rank rise to fourth place among the world's 91 comprehensive engineering journals." The editor-in-chief has stated that requesting contributions has become part of the journal's activities: "Zhou Ji, the president of the Chinese Academy of Engineering who served as director of the Chinese Ministry of Education, has been emphasizing for several years that journals must be developed in a major way. President Zhou holds monthly meetings with the editors-in-chief of journals in nine different fields to discuss the direction of topic selection and the task of requesting contributions." The journal's editor-in-chief Wu also stated, "It is an important task of *Engineering* to plan, select topics, and publish international advanced engineering research on key national needs." He explained, "We have partnered with internationally renowned scientific databases and participated in the research project Global Engineering Advanced Research of the Chinese Academy of Engineering. The publication combines big data analysis with expert review and judgment to carefully select the latest research, development highlights, and cutting-edge research in the field of engineering and technology and asks outstanding scientists in related fields to write or contribute manuscripts to the publication. In this way, we are guiding the direction of development in a certain field." In the case of another journal, deputy editor-in-chief of *Journal of Pharmacy* (English) Wang Xiaoliang told the interviewer: "We have established a new overseas editorial board team. Under the leadership of the overseas editor-in-chief, the team strives to obtain quality manuscripts from abroad. The overseas deputy editor-in-chief is in charge of planning special thematic issues. The editorial team has an excellent scientific research team providing high-level manuscripts. The editorial office monitors technology news as needed and when they find outstanding and promising research activities, they promptly contact the researchers responsible and directly ask them to write a manuscript." Several other examples of journals are cited to illustrate the methods used by editors to get outstanding researchers to write and submit papers.

[217] Cao Xiuying, https://spc.jst.go.jp/hottopics/2107/r2107_cao.html (accessed July 12, 2021)

[218] Cao Xiuying, https://spc.jst.go.jp/hottopics/2107/r2107_cao2.html (accessed July 12, 2021)

In the case of internationally renowned journals such as *Nature*, *Science*, and *Cell*, it is common for outstanding, cutting-edge researchers to submit papers to journals with high SCI indices to demonstrate the quality of their results. In China, however, the editors themselves are the ones who judge the scientific value of research and then target the appropriate researchers to have them write and publish papers. While this in itself is unlikely to affect the scientific value of discoveries and ideas, it is a significant difference from the status quo in Europe and the U.S., where the value of papers is assessed in a free market competition. In other words, it is a method in which a certain group of people judge the scientific value of a discovery or idea, select it, request a paper, publish it, and present it to the public. This creates a virtuous cycle, encouraging foreign researchers to submit papers by increasing the value of the journal. Here, too, the "Chinese approach," which expects the "market" to function but always allows the organization's judgment and guidance to intervene, appears to have influenced journals' approach to publishing papers. It will be interesting to see how the strength in numbers of China, which is said to be the second country in the world for the number of papers published, will affect the way in which researchers from other major countries publish their papers.

4.2 Policy documents related to journals and papers

Having introduced policy documents on basic research promotion and scientific research management reform in Chapter 2, here, we will introduce the guiding opinions issued about journals and papers.

4.2.1 August 16, 2019, China Association for Science and Technology, Central Propaganda Department of the Communist Party of China, Ministry of Education, and Ministry of Science and Technology, "Opinions on deepening reform to cultivate world-class STM journals"

These opinions were published by Xinhua News Agency on August 16, 2019, and were issued to deepen reforms related to the cultivation of world-class STM (Science, Technology, and Mathematics) journals. First, we will outline the opinions along with the main text of the release.

Although the development of STM journals is a rather technical and specialized matter, as usual, the opening paragraph states that the aim is to realize the "Chinese dream" under the guidance of "General Secretary Xi Jinping's socialist ideology with Chinese characteristics for a new era," and everything is constructed under this guiding ideology.

The basic principles are to foster "top-level" journals, "focus on the key needs of the country and areas that must be competitive in the technology development strategy; strengthen departments that have a competitive edge; fill in gaps; reinforce weak points; solidify the foundation for development; and build systems, mechanisms, and ecological guarantees for the sustainable development of journals." However, this project is based on the pursuit of "breakthroughs through innovation," and "the international reach and influence of Chinese STM journals" is considered important.

To that end, the concrete objectives are to significantly increase the number of STM journals that will become world-class journals in the next five years and to significantly enhance "academic organizational strength," "human resource cohesion," "innovation traction," and "international influence." In particular, China will "develop new journals in emerging interdisciplinary and strategic advanced fields" and "optimize and upgrade Chinese-language STM journals and develop and enhance science journals." The goal is to "raise the overall competence of Chinese STM journals to the world's leading group by 2035."

The key mission is to implement the Action Plan for the Excellence of Chinese STM Journals and build a "world-class

Chinese STM journal system." Specifically, the following tasks are considered important: "focusing on improving the operational capacity of the STM journal publishing market"; "encouraging enterprises to leverage their strengths and jointly publish journals in accordance with the national entry policy and publication management system"; building new mechanisms for competition-driven open cooperation; promoting the collective development of STM journal publishing through a new business model characterized by cooperation between academia and enterprises, universities and enterprises, and central and local governments; strengthening journal publishing by academic societies; "focusing on improving competitiveness" by "strengthening academic traction and attractiveness for high-level authors," "attracting high-level global editorial boards and management talents," and "actively participating in global scholarship and governance, deepening cooperation with global peers, and improving the ability to develop and compete in the marketplace." In particular, to bring the quality and value of Chinese STM journals on par with foreign countries, "a list of ranked journals will be published, and evaluation criteria reflecting their level will be established to attract high-level papers to be published in Chinese STM journals for the first time, thus contributing to the country's innovation-driven development strategy." Finally, as always, the "Safeguard measures" mention "strengthening the overall leadership of the Communist Party." Expressions such as "defending General Secretary Xi's position as the core of the CPC Central Committee and the Communist Party of China" are standard phrases, whereas the use of the expression "promote the effective integration of government guidance and social capital" and the recommendation of publishing journals through cooperation and collaboration with so-called leading Western publishers are particularly noteworthy. On the other hand, the progress of reforms must be monitored more closely, and all parties concerned must remain vigilant.

This concludes the outline of these opinions. The goal is to have strong technology-oriented journals take center stage as "STM journals." These opinions can be summarized as follows. China will foster and demonstrate its own academic leadership, gather the wisdom of world-class high-level experts and journal specialists, build a database of papers that ranks first in the world in terms of quantity, compete for innovativeness under China's unique evaluation criteria, give priority to submissions to Chinese-language journals if possible, and utilize government guidance and market forces, that is, the competence (know-how, network, etc.) of leading Western publishers to create China-led STM journals. It is said that a Five-year Plan will be developed for this purpose and that these goals will be achieved by 2035. The key point is to "compete for innovativeness under China's unique evaluation criteria."

The Scholarly Kitchen[219] by the Society for Scholarly Publishing (SSP)[220] refers to the above-mentioned August 16, 2018, "Opinions on deepening reform to cultivate world-class STM journals."

According to *The Scholarly Kitchen*, the Action Plan for the Excellence of Chinese STM Journals[221] has been developed as a key mission and has been published on January 21, 2020. The plan is based on the "Opinions on

[219] Tao Tao, "China Strives to Catch Up on STM Publishing: An Interview with Dr. Zong-Ming Cheng and Dr. Xiaofeng Wang," The Scholarly Kitchen, December 2, 2019, https://scholarlykitchen.sspnet.org/2019/12/02/china-strives-to-catch-up-on-stm-publishing-an-interview-with-dr-zong-ming-cheng-and-dr-xiaofeng-wang/ (accessed June 22, 2021)

[220] The Society for Scholarly Publishing (SSP), founded in 1978, is a nonprofit organization formed to promote and advance communication among all sectors of the scholarly publication community through networking, information dissemination, and facilitation of new developments in the field.

[221] 《中国科技期刊卓越行动计划》, http://www.epublib.com/h-nd-99.html (accessed August 11, 2021). This plan is under the jurisdiction of the Chinese Ministry of Education, Ministry of Science and Technology, Ministry of Finance, CAS, GAPP, the Chinese Academy of Sciences, and the Chinese Academy of Engineering. This English translation is based on a Japanese translation of the original using DeepL Translate.

deepening reform to cultivate world-class STM journals" formulated by CAST, the Central Propaganda Department of the Communist Party of China, the Ministry of Education, and the Ministry of Science and Technology. It establishes "a five-year cycle plan to build a support system for national science and technology journals" and it "optimizes the structural layout of science and technology journals and publishing and enhances their professional management capacity, their ability to operate in the publishing market, and their international competitiveness." The plan divides the journals into five tiers, "Leading Journal Projects," "Key Journal Projects," "Echelon Journal Projects," "High Starting Point New Journal Projects," and "Clustering Pilot Projects" and determines the contents and financial support for each one. Among them, Leading Journals are required to aim to become the world's top journals within five years, and Key Journals are also required to compete with Leading Journals. High Starting Point New Journals are, in essence, those that are founded in collaboration with journals that have already established themselves as leading international journals (e.g., *Nature*). Although the differences between the various categories of journals are not always exactly clear, in relation to the promotion of basic research, which is the point of interest here, the terms "basic research" and "strategic frontier" are used for Echelon Journals and High Starting Point New Journals. For Echelon Journals, "basic research" is included as a category along with "technology" and "science dissemination," and "English-language journals must be included in major international journal databases." Overall, there is little enthusiasm for publishing journals that emphasize basic research. Leading Journals, on the other hand, are required to "publish original innovations that reflect the international level of development, publish the results of original innovations in major science and technology, steadily increase the volume of papers while maintaining academic quality, and be included in the top 50% of important international databases and major citation indices in their field." They are also required to "have an impact factor and total citation index that are at the top of their field and a proportion of international papers that is at least 50%." Interestingly, in addition to the editor-in-chief being a leading expert in the field, the journal's organizational effectiveness is also described as having "an editorial board that covers major domestic and international academic centers in the field and plays a substantial role, and an editorial team that includes a global, high-level team of reviewers." However, it is important to indicate the specific composition of the editorial board members to know how the editorial structure can encompass the "major domestic and international academic centers in the field."

According to the journal designations and financial support announced on November 25, 2019, under the aforementioned plan, approximately USD 29 million will be invested in the first year to support 285 journals[222], including 280 existing journals[223]. Plans are made to support the publication of 30 more journals over the next four years, accepting applications for new journals immediately and completing the selection process by November 25, 2019. The details of how support for these journals will be provided are not known. However, it is believed that journals will be ranked in three tiers, and support for these tiers will be provided approximately as follows[224]. Tier 1 (Leading Journal Projects, 领军期刊类项目) will consist of 22 journals to be published in English, and each journal will receive between CNY 1 million and CNY 5.2 million in funding to encourage submissions from around the

222 285 (journal) projects selected for the China Science and Technology Journal Excellence Action Plan http://news.sciencenet.cn/htmlnews/2019/11/433140.shtm (accessed June 24, 2021)

223 David Cyranoski, "China splashes millions on hundreds of home-grown journals," Nature, NEWS, 11 December 2019, https://www.nature.com/articles/d41586-019-03770-3 (accessed June 24, 2021)

224 David Cyranoski, *ibid.*

world. Tier 2 (Key Journal Projects, 重点期刊类项目) will consist of 29 journals to be published in English, and each journal will receive between CNY 600,000 and CNY 1 million in financial support. Tier 3 (Echelon Journal Projects, 梯队期刊类项目) will consist of 199 journals (half of which will be published in Chinese), and each journal will receive CNY 400,000 in funding. A further 30 journals will be selected as “High Starting Point New Journal Projects” (高起点新刊类项目)” and will receive CNY 500,000 per year in funding. According to this announcement, the so-called “Clustering Pilot Projects” (集群化试点项目), will include China Science Publishing & Media Co., Ltd. (CAS), Chinese Laser Press Co., Ltd. (CAS), Higher Education Press Co., Ltd. (Ministry of Education), Youke Publishing Co., Ltd. (CAST), and the Chinese Medical Association (CAST) and will receive between CNY 5 million and CNY 5.7625 million in funding.

The investment will be monitored by a committee of seven key agencies, including the Ministry of Science and Technology, the Ministry of Finance, and GAPP. The plan also marks a milestone in the history of STM-related journals in China, which will be promoted as a national project with seven journal categories[225]. Many Chinese researchers returning from Europe and the U.S. are also increasingly demanding Chinese journals that are appropriate for their level of research, and these measures are intended to meet that demand. However, there is no specific policy on how the results will be evaluated, and it is said that evaluation may rely on the journals’ impact factor. Moreover, from an international perspective, the meaning and significance of supporting academic journals with public funds is a matter of debate.

According to this article by *The Scholarly Kitchen*, reform of Chinese journals began in 2013, leading to the development of a 2019 action plan. In the meantime, the quality of journals was also improved by inviting foreign editors[226] to join journals, and progress was made in manuscript review processes and cooperation with international publishers.

Notably, 75% of Chinese STM journals are published in English in cooperation with international publishers[227]. Through such cooperation, international publishers can approach the huge Chinese journal market, and the Chinese side can gain know-how on publishing journals that adhere to international standards and attract foreign researchers to Chinese journals. Moreover, under this cooperative system, it is not necessary to obtain the Chinese CN number, as mentioned above. This system allows journals to begin publication with only an ISSN number and obtain a CN number once the journal is active. However, it has been pointed out that under this system, international publishers unfairly benefit through this opportunity, and the issue of copyright ownership when cooperation ends is unclear. While commending the efforts being made through this action plan, the article also noted that few Chinese publishers are active in the international journal community, and it will be a long time before Chinese journals are able to compete with international publishers. In recognition of this, Chinese journal publishers hope to build their own publishing platforms through timely use of information technology and further proficiency in English, so that international cooperation will enable wider sharing of knowledge and free global distribution of information.

225 The seven categories include leading journals, key journals, echelon journals, high starting point journals, clustering pilots, international digital publishing service platforms, and high-level journal personnel. Out of 285 journals, 209 are registered in Scopus. https://en.library.ipm.edu.mo/research-tips-07 (accessed June 22, 2021)

226 This article mentions *Cell Research* Editor Dr. Dangsheng Li, Research Editor Dr. Tianhong Cui from University of Minnesota, *Plant Phenomics* editors Seishi Ninomiya, University of Tokyo, and Frederic Baret, French National Institute for Agricultural Research.

227 In November 2019, “Edition Diffusion Press Sciences (EDP Sciences),” a French STM journal published in English and French, was bought by a Chinese publisher for the first time.

However, even if Chinese journals develop in cooperation with international publishers and publish journals that meet global standards to the extent that non-Chinese papers are also published, there is no guarantee such global standards will continue to be adhered to.

Another March 2020 article in *The Scholarly Kitchen*[228] reported that researchers were not that surprised by the policy prohibiting researchers from using the SCI index for papers. This is because the reform of research evaluation in China had already begun in 2016. That year, at the 29th Meeting of the Central Leading Team for Comprehensively Deepening Reform, General Secretary Xi Jinping stated the need to "improve professional evaluation standards, innovate professional title evaluation mechanisms," emphasize "morality, competence, and performance orientation," overcome the trend of "only academic background, titles, and papers," and evaluate professional and technical talent scientifically, objectively, and fairly[229]." He further stated that professional evaluations should not be based solely on publications. With this in mind, a series of policy documents on metric-driven academic systems were issued, and universities, scientific institutes, and funding agencies strived to reverse the phenomenon of SCI-supremacy. Further, 2016 was also the year that the number of papers by Chinese researchers surpassed that of the U.S[230]. In 2017, the number of citations of Chinese researchers' papers ranked second in the world after the United States. In other words, China achieved the goal of the 2006-2020 Medium- and Long-Term Program, namely, to be among "the top five countries" in terms of "citations of scientific papers." This led to the 2018 General Office of the Communist Party of China and Central Office of the State Council "Opinions on further strengthening credit building in scientific research[231]," which encouraged universities and scientific institutes to develop their own action plans. In early 2019, Wuhan University was in the process of stopping financial support for submissions to SCI-indexed journals, considering instead a "white list" of preferred journals, which was expected to include more Chinese journals. The new rule became "fewer but better." If researchers want to receive government financial support, at least one third of their papers must be published in Chinese journals. Furthermore, the NSFC changed its application rules starting with the 2020 selection. The article reports that this is a considerable relief to the researchers who apply, as they do not have to fill out cumbersome forms. On the other hand, for young researchers who do not have sufficient research networks, contributions to journals with a clear SCI index are an objective and reliable indicator. Moreover, submissions to Chinese journals probably have high rejection rates and much longer waiting times for publication. It is expected that the burden on doctoral students will be reduced because universities will likely change their judging criteria. The increased emphasis on qualitative evaluation will allow full-time professors and researchers to spend more time on innovative research and eliminate the need to work relentlessly to increase the number of publications, although it will still be necessary to make an effort to publish in international journals. There are some differences by discipline, as in general, English is not the lingua franca of the humanities and social sciences, which welcome

228 Jie Xu, "Guest Post - How China's New Policy May Change Researchers' Publishing Behavior," March 3, 2020, https://scholarlykitchen.sspnet.org/2020/03/03/guest-post-how-chinas-new-policy-may-change-researchers-publishing-behavior/ (accessed June 23, 2021). The author, Dr. Xu of the School of Information Management, Wuhan University of China, was unable to return home after the COVID-19 pandemic outbreak and was teaching online during that time.

229 习近平主持召开中央全面深化改革领导小组第二十九次会议、2016-11-01 18:33 来源：新华社 http://www.gov.cn/xinwen/2016-11/01/content_5127202.htm (accessed June 24, 2021)

230 Jeff Tollefson, "China declared world's largest producer of scientific articles," Nature, NEWS, 18 January 2018, https://www.nature.com/articles/d41586-018-00927-4 (accessed June 23, 2021)

231「中共中央办公厅 国务院办公厅印发《关于深化项目评审、人才评价、机构评估改革的意见》」(2018-05-30）. This opinion will be explained specifically in relation to research integrity in Chapter 5.

publications in Chinese-language journals. The new policy is favored as a healthy development in the world of applied sciences, as this field was also struggling under SCI-supremacy. Clinicians support this policy as it will increase their opportunities for promotion since they are too busy operating to write papers.

However, for international journal publishers, this presents both important opportunities and difficult challenges. Chinese researchers will no longer submit papers to blacklisted journals, and these journals will lose market share. Meanwhile, experienced researchers will select highly regarded, top-tier international journals, and competition will become increasingly intense. The new policy focuses on originality and scientific value, which is exactly what is being pursued in the journal peer review process. As Chinese researchers submit their original and scientifically valuable results to Chinese journals, international journal publishers will have the opportunity to collaborate with Chinese journals to develop or expand their markets. Another opportunity could be for international journal publishers to provide professional services to Chinese universities and scientific institutes through publication of international conference proceedings, English editing, English translation, and author support for expanding into international markets. Finally, the author concludes that China is now an important part of the global scientific community and has become more strongly involved in international research activities and that the development of a sound academic reputation system in China has the potential to benefit the entire global scholarly communication ecosystem and further reshape global STM publishing.

As a representative example of so-called Western views on this measure, we will look at a February 25, 2020, article[232] from *University World News*, a network of international university-related journals. The main observations of the article are presented below.

The measures taken by China will free researchers from the "publish-or-perish culture" that "pressures" researchers to submit papers to international journals. The shift from SCI-supremacy will lead to a decrease in SCI papers from Chinese universities, currently ranked second in the world, which will cause their international ranking to drop. At the same time, this will have an impact on the attitude of young researchers toward research. Originally, General Secretary Xi Jinping expressed the opinion that China's higher education should be based on China-specific standards and norms, rather than guided by Western ideas and standards. In a sense, this also means that research should aim to solve problems that are specific to China. The situation in the future will be such that even if a manuscript is published in a leading international journal such as *Nature*, no financial support will be provided. These new guidelines state that evaluations should be made using indicators that do not rely on SCI. In other words, there should be a "citation index" that is specific to China. Publishing in leading international journals is interpreted, in essence, as Chinese science being "creamed off" by foreign peer reviewers who do not understand the Chinese situation. However, these measures would mean falling outside the mainstream of world science.

According to another article in *University World News*[233], these measures show that it is riskier for researchers in the humanities and social sciences, whose research projects are related to sensitive issues in Chinese society, to submit to journals with higher indices than for researchers in the natural sciences. Perhaps, these measures may

232 Yojana Sharma, "China shifts from reliance on international publications," University World News, 25 February 2020 https://www.universityworldnews.com/post.php?story=20200225181649179#:˜:text=Moving%20away%20from%20international%20 research,China%20should%20 have%20its%20own (accessed June 21, 2021)

233 Futao Huang, "China is choosing its own path on academic evaluation," University World News, 26 February 2020, https://www.universityworldnews.com/post.php?story=20200226122508451#:˜:text=On%2018%20February%202020%2C%20the,of%20 China's%20academic%20evaluation%20system. (accessed June 21, 2021)

induce researchers in the humanities and social sciences not to submit to international journals. Researchers in these fields are not allowed to study issues such as “academic freedom,” “institutional autonomy,” the “dominant control of the Communist Party over higher education and research,” and “academic corruption.” Moreover, researchers in the humanities and social sciences form only relatively small international networks compared to those in the natural sciences. According to this article, China is attempting to make the choice that Chinese researchers should conduct research in a unique context to solve China’s own problems, rather than contribute to world science, and that there should be an index to evaluate their work from that perspective. However, establishing new evaluation standards to replace those that have been accepted by the international academic community is an extremely daunting task. This presents a very wide range of questions, such as who will create the standards, how they will relate to the current system, which will be included in the evaluation of doctoral students, the evaluation of academic achievements of researchers, the evaluation for the promotion of young researchers, and the international reputation of Chinese higher education and research in general. Another issue is the volume of submissions. Some young researchers with small budgets are forced to submit to so-called predatory journals, and some Chinese researchers still hope to submit their papers to SCI journals, as they themselves trust the somewhat objective value of the impact factor, in the case of international research collaborations with foreign researchers. Many researchers are publishing papers in Chinese to begin with, and these researchers will be increasingly isolated from the rest of the world. This is also expected to result in lower university rankings. Many researchers are not convinced of the necessity of such journals at a time when China is already becoming an important powerhouse in world science. In particular, researchers do not see the place of publication of a journal as significant, and it is almost inconceivable that non-Chinese researchers who do not understand Chinese would submit to a Chinese journal. Chinese journals could also charge a reduced article fee to Chinese researchers, which would save Chinese researchers money on research costs. This is an extremely significant challenge for the government, as no concrete suggestions are given in the series of plans. Some are concerned that this measure may be the result of impatience on the part of government leadership, which is lamenting the lack of tangible social and economic results despite the large amount of investment being made in the project.

Identifying the leading edge of so-called basic research requires knowledge of the direction of researchers around the world to mutually understand the directions being pursued. However, given that China has a critical mass of researchers in a variety of fields, numbering around 1.8 million, it is clear that Chinese researchers have the ability to open up new frontiers of basic research in certain fields.

4.2.2 February 17, 2020, Notice of the Ministry of Science and Technology, “Measures to eliminate the erroneous ‘paper only’ mentality in science and technology evaluation (trial)[234]”

The abovementioned policy document “Guidelines for activities to strengthen basic research,” dated January 21, 2020, expresses the position that evaluation should not be based on the number of papers. However, until that time, the growth in the number of Chinese papers was often emphasized. The (trial) measures described above served to discourage this phenomenon. This was based on the observation that the emphasis on the number of papers and the

234 《关于破除科技评价中“唯论文“不良导向的若干措施（试行）》
http://news.sciencenet.cn/htmlnews/2020/2/436125.shtm (accessed June 18, 2020)

impact factor led to a decline in the quality of papers and to research misconduct. Incidentally, the move to correct the negative effects of overemphasis on the number of papers is also reflected in a notice from the China National Intellectual Property Administration (CNIPA) that takes issue with the current situation in which subsidies are given and awards are made based on the number of patent applications[235].

The measures outlined in the notice are summarized below.

Simply put, these measures aim to "eliminate the negative effects of 'paper-only' reliance in the evaluation of science and technology, which places undue emphasis on the number of papers and their impact factor, while neglecting the quality, contribution, and impact of representative achievements." These measures will "strengthen guidance through classified review and evaluation, emphasize the quality of innovation and overall performance in the deliberation and evaluation of national science and technology plan projects (research topics), emphasize support service capabilities in the evaluation of national science and technology innovation bases, emphasize mission accomplishment in the evaluation of the performance of central-level science and technology initiatives, emphasize the review of achievement quality and contributions in national science and technology promotion, emphasize the spirit of scientists, strengthen competence and performance in the selection of talents for the Innovative Talent Promotion Program, establish and cultivate high-quality scientific and technological journals in China, strengthen expenditure control for the publication of papers, and strengthen supervision and inspection."

Although not all of the provisions will be mentioned here, for example, for basic research, "emphasis is placed on the evaluation of the quality, contribution, and impact of representative results such as new discoveries." For the evaluation of papers, "the number of representative works is reasonably determined based on the characteristics of the scientific and technological activity (up to five papers for individual research, up to ten papers for key issue innovation team research, etc.)." Of these, "in principle, not less than one third should be papers published in domestic science and technology journals." As is repeated elsewhere, the emphasis is on "not using the number of representative works or the impact factor as indicators for quantitative screening and evaluation." According to *Nature*, universities and research institutions were required to revise their evaluation policies by July 31 of the same year, failing which their financial support would be suspended[236].

Even more interesting is the "weighting of review and evaluation for high quality results." The weighting may be increased to 10% for a certain academic impact and actual applied effect, 30% for a significant academic impact and a leading role in innovation in the relevant field, and 50% for an important contribution to economic and social development and national security.

The science and technology journals (scientific journals) in which papers are to be published are "national science and technology journals of international influence, international top-level or important science and technology journals accredited in the field, and top-level national and international scientific conferences." Researchers are encouraged to publish papers in these journals (called the "three types of high-quality papers"). On the contrary, "fund management measures appropriate to eliminate 'papers only' reliance will be established," and financial support

235 Nagoya International Patent & Trademark Office, February 9, 2021 [Overseas IP Information] "China Promotes Shift from Pursuit of Number of Patent Applications to Improvement of Quality," https://www.patent.gr.jp/news/shosai.html?id=932135357601cf9f7dfc68 For the original text, see: 国家知识产权局关于进一步严格规范专利申请行为的通知 (January 27, 2021).

236 Smriti Mallapaty, "China bans cash rewards for publishing papers", Nature, 28 February 2020, https://www.nature.com/articles/d41586-020-00574-8 (accessed June 13, 2021)

will not be granted for the publication of papers that do not meet certain conditions. In addition, "journals with low administrative and academic credibility and commercial interests will be added to a 'blacklist'" and "early warning mechanisms for journals will be put in place[237]."

In principle, the number of representative works should not exceed five for basic research, and a maximum number of representative works is also stipulated in the evaluation of papers for other projects (project research at national laboratories, etc.). In addition, it is stipulated that in various project evaluations, institutional evaluations, rewards, and personnel selections, papers will not be the main basis for evaluation or index for review, and there will be a limit on the number of representative works.

Here is a further explanation of the above policies with reference to an article by *The Scholarly Kitchen*[238], which is particularly relevant to basic research.

These (trial) measures will establish a China-specific and internationally impactful scientific citation index to accelerate the action plan and encourage publication of government-funded research in domestic high-quality STM journals. The quality of academic journals will be monitored, and an early warning list of national and international journals will be published on a regular basis. Titles on the list will be constantly tracked and adjusted in a timely manner, and those with poor management or low-quality academic reputation or those with commercial interests as their primary concern will be blacklisted. For representative works, financial support will be provided through a special fund under the "National Science and Technology Plan." Other papers that are not considered representative works will not be paid from this fund. If the publication cost of a single paper exceeds CNY 20,000 (approximately USD 3,000), the cost will be paid after the academic committee of the institution to which the corresponding author or first author belongs has reviewed and approved the need for publishing the paper. If a paper is found to have been published in a journal on the blacklist or early warning list, the publication cost will not be allocated from the "National Science and Technology Plan Fund." Those who violate this regulation will forfeit the publication costs paid, and the remaining funds for the related project will be recovered. Universities and scientific institutes must oversee the need of all publications and must not use an incentive system based on the number of papers published or the impact factor of papers for researchers. The implementation of these measures will be strictly supervised and monitored.

The meaning of these measures and the views expressed in the article are summarized below.

First, the number of Chinese authors submitting papers to English-language journals is likely to decrease. However, this decrease will affect submissions to low-quality journals. Submissions to high-quality, top-tier journals will be rather encouraged and expected to increase. Although researchers are instructed to publish one-third of their papers in Chinese journals, half of the 280 titles listed in the Action Plan for the Excellence of Chinese STM Journals are Chinese-language journals, and there are questions as to whether these journals can meet the demand for papers. However, most of the English-language journals in China are co-published with international publishers, and as long as they obtain a CN number, they are considered domestic Chinese journals. Therefore, the CNY 20,000 (about USD 3,000) publication cost cap may become a criterion for researchers to choose where to publish their papers. A higher article processing charge (APC), including the selection fee, would be problematic. In the past, China has tended to

237 This blacklist is a list of so-called predatory journals, also known as deceptive journals. Here, it is stated that warnings will be issued against predatory journals.

238 Tao Tao, "New Chinese Policy Could Reshape Global STM Publishing," The Scholarly Kitchen, Feb. 27, 2020, https://scholarlykitchen.sspnet.org/2020/ 02/27/new-chinese-policy-could-reshape-global-stm-publishing/ (accessed June 23, 2021)

seek publication in journals covering a wide range of fields with high impact factors. However, in the future, journals in specific fields with low impact factors may also have more opportunities, depending on how they are publicized. To increase submissions of the best Chinese papers in the future, both journals and international conferences will have to ensure that they are included in the above “three types of high-quality papers” and not on a “blacklist” or “early warning list.“

In addition to the above (trial) measures, policies are defined with respect to the “creation and cultivation of high-quality science and technology journals in China.” One of them is the “establishment of English-language journals with high starting points[239],” followed by the improvement of “the quality of English abstracts in Chinese-language journals.” However, the statement that “government-funded papers are encouraged to be published in high-quality domestic science and technology journals” is extremely problematic from the perspective of the procedures for publishing papers. Funamori Miho of the National Institute of Informatics notes that some of the above opinions, such as the evaluation of the quality rather than the quantity of papers and the concept of not evaluating papers based on impact factor, were already included in the San Francisco Declaration on Research Assessment (DORA)[240], among other documents. In general, these policies have not been effective in practice, and researchers are still pursuing number of papers and impact factor, although China’s strict policies are commendable[241]. At first glance, quantitative evaluation of research content and researchers is certainly easy for those in charge. However, it is highly doubtful that it directly reflects evaluation in the academic sense, and questions are always raised on the matter. If China can take on this challenge, future developments will be of great interest to the world’s scientific community. The same problem has often been raised in Japan, as well[242]. Recently, the report of the MEXT Committee on R&D Issues in the Era of Open Science from the Perspective of Policy Evaluation[243] discussed the qualitative evaluation of papers, mentioning “the effectiveness of peer review, expert judges, and expert panels in qualitative evaluation” and sought to introduce a new perspective with respect to quantitative evaluation based on impact factor and other elements.

239 “High starting points” refer to publishing an English-language journal in China in collaboration with an international publisher such as *Nature*. *Genes & Diseases*, *Light: Science & Applications*, and other journals are the targets of the Action Plan described below. *Genes & Diseases*, launched in 2014, is a journal focusing on basic molecular and experimental translational medicine for human diseases. The journal currently has 176 researchers from 18 countries on its editorial board, has published 29 volumes, and boasts a bibliography of more than 700,000 articles. Mary Kennedy, “New Elite Chinese STEM Journal, Genes & Diseases,” ScienceOpen, May 12, 2021, https://blog.scienceopen.com/2021/05/elite-chinese-journal-genes-and-diseases/ (accessed June 26, 2020)

240 San Francisco Declaration on Research Assessment, https://sfdora.org/read/ (accessed June 22, 2021)

241 Funamori
Miho, “China regulates the use of SCI papers and related indicators in research evaluation,” Foreign Higher Education Affairs No. 23, pp. 45-52, file:///C:/Users/takayuki.shirao.kf/Desktop/%E3%82%A2%E3%82%B8%E3%82%A2%E5%%. A4%AA%E5%B9%B3%E6%B4%8B%E3%82%BB%E3%83%B3%E3%82%BF%E3%83%BC/%E4%B8%AD%E5%9B%BD/%E5%A0%B1%E5%91%8A%E6%9B%B8/%E6%B5%B7%E5%A4%96%E9 AB%98%E7%AD%89%E6%95%99%E8%82%B2%E4%BA%8B%E6%83%852%E5%B9%B44%E6%9C%88%EF%BC%8845-52%EF%BC%89.pdf (accessed June 22, 2021)

242 Tsuji Atsuko, “A departure from research evaluation relying on simple numerical values,” Chemistry and Chemical Industry, Vol. 74-12, December 2021, https://www.chemistry.or.jp/opinion/ronsetsu2112.pdf (accessed May 1, 2022) and others.

243 Committee on R&D Issues in the Era of Open Science from the Perspective of Policy Evaluation, “R&D Evaluation Issues for a New Era:Toward Better Promotion of Research Activities,” July 30, 2021, https://www.mext.go.jp/content/20210730-mxt_kanseisk02-000017162_s6.pdf (accessed May 1, 2022)

4.2.3 February 20, 2020, Ministry of Education and Ministry of Science and Technology, "Opinions on the appropriate use of SCI-related indicators and orientation of research evaluation in the regulation of higher education institutions[244]"

These opinions are arguably directed at organizations in response to the above (trial) measures. We will first give an outline of the opinions.

The document is short (10 items), and as the title indicates, it aims to strengthen the "attitude and academic culture of scientific research and scientific research with integrity." To that end, various scientific research institutions, universities, enterprises, and social organizations are required to carry out various actions as "relevant organizations," which are given the primary responsibility for implementing these actions. The meaning of the "important instructions and spirit of General Secretary Xi Jinping's attitude and academic culture toward scientific research" mentioned at the beginning is not fully clear.

First of all, at the outset, each relevant organization is requested to schedule important steps to follow these instructions and spirit and to report on the status of the investigation and handling of issues. Next, agencies are to ensure that the abovementioned measures are enforced. These include the promotion of the quality and level of papers, the prohibition of associating the number of papers published with incentives and bonuses, and the prohibition of the use of specific project funds to reward the publication of papers. The opinions include somewhat detailed provisions on recording scientific research data, executing the submission of such data, ensuring its traceability, examining the state of research attitudes and academic culture, ensuring education and management, rigorously checking the scholarship and reliability of papers, and making corrective efforts and combating problems in the aforementioned attitudes and academic culture. In addition, applications for projects are subject to a clear commitment of responsibility by each of these related organizations, approval of various activities (e.g., technology activities) based on the commitment signed by each related organization, and rejection of the application by the Ministry of Science and Technology and NSFC in case of any problems. The status of the above responsibilities will be incorporated into the credit record, and furthermore, if there are problems, the project will be subject to focused supervision.

In summary, each relevant organization is responsible for having its researchers follow the specifics of this "attitude and academic culture of scientific research and scientific research with integrity," and the organization is fully responsible for supervising the conduct of these individual researchers.

It is expected that the above measures and opinions will change the attitude of Chinese researchers toward papers. The number of Chinese papers, their impact factor,[245] and the methods for evaluating the scientific value of papers that China may devise in the future will need to be followed up on.

An interesting international reaction published after these measures and opinions were issued is discussed in

244 Ministry of Education, Ministry of Science and Technology 印发《关于规范高等学校SCI论文相关指标使用 树立正确评价导向的若干意见》的通知

245 This report does not intend to promote the trend of overemphasizing impact factor in relation to the value of papers. The attitudes of the scientific community in China and in Japan, the U.S., and Europe, should be closely observed, taking into account the warning sounded by JST/CRDS Director Noyori Ryoji. See Noyori Ryoji, JST/CRDS Director, "'Faith' in Name Brand Scientific Journals," JST/CRDS, Column "From Director Noyori's Office," November 7, 2017, https://www.jst.go.jp/crds/column/director-central- room/column20.html (accessed 8 May 2022)

an article by the Max Planck Institute, dated November 19, 2020[246]. The article emphasizes that "universities and research institutions are now banned from setting up quantitative goals and from offering financial incentives for researchers' publishing behavior using SCI-related metrics. The number of SCI-papers published should also not be used as the main criterion for rewarding degrees, recruiting and promoting personnel, ranking institutions and disciplines, or assigning funding and prizes. (...) For researchers in basic science (...) scholars can choose no more than five representative papers each year, one third of which must be published in Chinese journals (...) Publication in top international journals (e.g., *Cell*, *Nature*, and *Science*) is still encouraged, but equally important is appearing in the domestic ones."

This column from the Max Planck Institute for the History of Science predicts that these measures will lead to a major rethinking of the practice of submitting English-language papers, which has been encouraged, even rewarded, in the past, and that they will also reduce research misconduct and eliminate redundant self-citations. Chinese researchers themselves also welcome the end of "SCI-supremacy" and believe they will be freed from the constant stress of writing papers. However, at the same time, there is uncertainty owing to the lack of instructions on specific evaluation methods and doubts about approaches such as academic peer review, which is considered subjective and prone to misconduct due to cliquish favoritism. These measures are also expected to eliminate poor quality filler papers and reduce the total number of Chinese papers being published. In fact, as the measures are implemented, attention should be paid to their impact on the CPC Central Committee's control over the publication of scientific findings and the impact on the incentives for Chinese researchers to cooperate internationally, in addition to the quantitative changes that will soon result from the new policy.

In summary, these (trial) measures clearly emphasize the need to evaluate the quality of papers rather than the number of papers or their impact factor. Further, they also call for the evaluation of a limited number of representative works, specifically up to five representative works in the case of basic research, weighting of high-quality works (up to 50%), and careful selection of publication sites (three types are designated). The measure emphasizes performance in the allocation of various funds, personnel, and rewards (which themselves should not be based on papers), as well as the promotion of the development of high-quality journals and the elimination of low-quality journals (through the creation of a blacklist of low-quality journals). In addition, the measures limit financial expenditures for the publication of papers (up to CNY 20,000 per paper, with any excess requiring a review). Steps are taken to ensure supervision and inspection for the above measures and disciplinary action in case of problems, and authorship management for paper publication is strengthened. Although the importance of the quality of papers is easy to take for granted, these measures may be motivated by concern over the proliferation of predatory journals and the fact that contributions to these journals are also included in evaluations. However, measures such as limiting the number of papers to be reviewed, controlling financial expenditures for the publication of papers, and punishing those who violate the rules seem to be mistaking the means for the end. The measures conclude by stating that the government will "strengthen the promotion of positive typical cases and establish accurate public opinion guidance." Whether or not it is accurate, the very act of dictating public opinion creates an atmosphere of mutual surveillance that is detrimental to a completely free academic climate. Although peer review should evaluate the content of research,

[246] SONIA QINGYANG LI, LISE MEITNER RESEARCH GROUP, Max-Planck Institute for History of Science, "The End of Publish or Perish? China's New Policy on Research Evaluation," Nov 19, 2020, https://www.mpiwg-berlin.mpg.de/observations/1/end-publish-or-perish- chinas-new-policy-research-evaluation (accessed June 11, 2020)

in Chinese peer review, which is not yet mature enough, more subjective factors related to researchers' loyalty and service to the Party may become relevant. It is also concerning that there are no concrete plans for implementing these measures, such as criteria for qualitative evaluation in peer review, or instructions on the types of contributions to be evaluated. In any case, the results of the trial measures will be worthy of attention.

Lists of low-quality journals are apparently being compiled by one organization after another. As of June 2021, the Ministry of Science and Technology is in the process of compiling its own list, and CAS (Center for the Study of Scientific Literature) has pioneered the publication of a blacklist[247].

4.3 Chinese journal policy, researchers' codes of conduct, and the future of open science

China will select and financially support designated journals through the Action Plan for the Excellence of Chinese STM Journals to improve the quality of all 4,000 to 5,000 journals in the country. To further connect outstanding papers to the world at large, the "F5000 platform" has been established to select and publish 5,000 papers, and a paper system with a pyramid-like structure has been created to recognize outstanding researchers. This system also includes SCI-indexed papers and is part of an international network, rather than simply a competitive platform to showcase exclusively Chinese-language papers. Publishing in journals of excellence, preferably including those indexed in SCI, and being selected for the F5000 platform will be recognized as a path to success for Chinese researchers, and this will inform their code of conduct. Foreign researchers will search for excellent Chinese papers through links to the F5000 platform and use them as a source of information in addition to SCI-indexed papers. However, it is unclear whether researchers around the world will be interested in publishing primarily in Chinese journals. CAST announced that "after the implementation of the Action Plan for the Excellence of Chinese STM Journals, the number of Chinese science and technology journals highly ranked in their disciplines has increased significantly" and that "in addition to the increase in the number of journals highly ranked in their disciplines, the recognition of Chinese science and technology publications abroad is also improving day by day[248]." However, it is difficult to evaluate this "progress" because no references are provided that can actually be evaluated.

The history of journals has undergone a transition in recent years with the spread of open science and open access mechanisms. Although initially confusing, a system for making information publicly available after a certain period of time has recently been established as a compromise with major publishers. The open science and open access

247 The Document Information Center of the Chinese Academy of Sciences officially released the International Journal Early Warning List (for testing purposes) on December 31, 2020. The list includes a total of 65 journals, identified based on objective data on indicators through expert consultation using a combination of qualitative and quantitative methods, with the aim of encouraging researchers to carefully choose where to publish. The list also cautions publishing institutions and others to strengthen the quality control of journals. http://www.igg.cas.cn/xwzx/kyjz/202101/t20210101_5849507.html (accessed June 19, 2021)

248 According to Science & Technology Daily, "The China Association for Science and Technology revealed at a press conference on February 17 that the number of Chinese science and technology journals highly ranked in their disciplines has increased significantly since the implementation of the Action Plan for the Excellence of Chinese STM Journals. Currently, 96 science and technology journals are in the top 25% of the world in discipline rankings, 25 are in the top 5%, 20 are in the top 3, and 7 are in the top spot. The impact factors of three publications, including *Cell Research*, exceed 20% and are in the world's top 100." Moreover, "the number of foreign institutions citing papers in Chinese science and technology journals increased from 864 to 9608, and the number of countries and regions citing them increased from 42 to 124." "China's 96 Science and Technology Publications Rank in Top 25% in the World in Discipline Ranking," Science Portal China, Science and Technology News, February 18, 2022, https://spc.jst.go.jp/news/220203/topic_5_03.html (accessed May 4, 2022)

initiatives in China are extremely interesting. This new infrastructure is an embodiment of the debate that has emerged in Europe and the United States. China does not appear to be adopting 100% of the practices of Western journals, which can be said to have developed on a market-oriented basis. As mentioned above, China is aiming to lead the world scientific community by demonstrating its own originality. Therefore, we might say that China's approach to open science and open access is still an unknown quantity. In other words, it may not be necessary for China to implement open science and open access ahead of Europe and the U.S., which have not yet reached the point of making papers widely available immediately after publication.

The Beijing Declaration on Research Data, adopted at the international conference held by the Committee on Data for Science and Technology in Beijing in September 2019, states in its preamble the following principles of data management and use: "Findable, Accessible, Interoperable, and Reusable." China emphasizes the principle that "Scientific discovery must not be impeded unnecessarily by fragmented and closed systems, and the stewardship of research data should avoid defaulting to the traditional, proprietary approach of scholarly publishing[249]." In the Progress of Science and Technology Law, which was amended and went into effect in early 2022, "the word 'open' appears 15 times, as opposed to only three times before the amendment. China is establishing the principles of open science by legislating them[250]." At the same time, China also cautions that "open science must be fully deployed around the world, or China's open science will not achieve the desired effect." Furthermore, "China will need to study the relationship between open science and national security, personal information security, confidentiality protection rules, and intellectual property rights rules in the future and promote open science while at the same time guaranteeing national security and security of personal information and ensuring that the rules of confidentiality protection and intellectual property rights are not violated." That much is certain. This is not a reservation unique to China, but it does mean that China is understandably sensitive to the extremely delicate and difficult questions that must be navigated today, when economic security issues weigh heavily on countries that are leading the way in innovation.

In light of the above, the development of China's journal policy is a matter of great interest, both for its impact on researchers' codes of conduct and for its relevance to the policies of major countries that maintain a leading role to ensure their economic security.

4.4 Chinese paper databases

According to the Institute of Scientific and Technical Information of China (ISTIC)[251], the country launched the China Science and Technology Papers and Citations Database (CSTPCD) in 1987, and by 2020, the database included 1,949 Chinese-language journals and 121 English-language journals in the field of natural sciences. In ISTIC announcements on the number of papers, the number of "domestic" papers is the number of papers included in CSTPCD, and the

249 Koiwai Tadamichi, [20-21] "Beijing Declaration on Research Data" Japanese Translation Released, Science Council of Japan for the Promotion Open Science, Science Portal China, Interview Report, August 24, 2020, https://spc.jst.go.jp/experiences/coverage/coverage_2021.html (accessed May 4, 2022)

250 Yan Wenjun (Professor, Center for Technology and Law Research, University of Chinese Academy of Sciences), "Riding the Wave of Technology Development on the Back of the Progress of Science and Technology Law," Science Portal China, Science and Technology News, April 19, 2022, https://spc.jst.go.jp/hottopics/ 2205/r2205_yan.html (accessed May 4, 2022)

251 ISTIC F5000 Top Articles from Outstanding S&T Journals of China, http://f5000.istic.ac.cn/f5000/index (accessed August 10, 2021)

number of "international" papers is generally the number of papers included in SCI[252]. In other words, in Ministry of Science and Technology materials, CSTPCD publications are described as "domestic," and SCI publications are described as "international." The Ministry of Science and Technology launched the "Strategic Research on China's Excellent Science and Technology Journals" and the "Service and Guarantee System for China's Excellent Science and Technology Journals." "China's Excellent Science and Technology Journals" (Outstanding S&T Journals of China) were selected by a cross-sectional leadership group consisting of the Ministry of Science and Technology, General Administration of Press and Publication, Publicity Department, Ministry of Health, CAST, Ministry of Education, and other organizations[253]. The results of the selection were published four times, in 2008, 2011, 2014, and 2017. This initiative improved the quality and influence of outstanding academic journals and drove the improvement of the overall level of Chinese science and technology journals. In 2020, the fifth annual China Technology Excellence Award was presented to 300 Chinese-language journals and 20 English-language journals.

"Databases of excellent papers" have been created as well. These are databases of papers published by ISTIC that aggregate papers in a certain field that have been cited n times or more in n years after publication and are deemed to be "excellent" and whose number of citations exceeds the global average. It is reasonable to assume that these criteria are not global standards but rather criteria independently evaluated and set by China. Moreover, ISTIC annually lists the 100 most influential international academic papers and the 100 most influential domestic academic papers in China at the end of the "Statistical Results of Chinese Science and Technology Papers."

Therefore, in terms of outstanding papers selected from a Chinese perspective, it is important to consider the papers in the above "databases of excellent papers" and the 100 domestic and 100 international papers for a total of 200 papers at the end of the "Statistical Results of Chinese Science and Technology Papers."

4.4.1 F5000 platform

Meanwhile, in 2012, ISTIC began researching and building a project to create a medium to showcase high-quality academic papers. The project's name is "Leader 5000 - Top Academic Papers Platform of Chinese Fine Science and Technology Journals (F5000)" (F5000 platform). The project is managed by China International Trust Investment Corporation (CITIC), which is working to increase the influence of the F5000 platform both within and outside China.

Among papers from journals selected as "China's Excellent Science and Technology Journals," up to 20 from the top 1% of papers for number of citations are selected and nominated in each field. The papers are further evaluated by the editorial board for innovation in research content, novelty in research methods, and accuracy and value of research results, and are entered into the F5000 platform after being formatted and refined as described below. The selection is made in line with the "Opinions on accurately understanding the role of science and technology journals in academic evaluation" issued by CAST, the Ministry of Education, GAPP, CAS, and the Chinese Academy of Engineering in November 2015. The opinions call for "establishing a fair and reasonable academic evaluation system" and for "emphasizing the innovative significance and applied value of scientific research results, reducing the utilitarian tone

252 In addition, databases used in many countries such as Ei, CPCI-S, SSCI, MEDLINE, and Scopus are also used (according to the JST Beijing Office).

253 ISTIC is said to have designed the "Chinese Science and Technology Journal Comprehensive Evaluation Index System" to select excellent journals using 24 academic indices, including citation indices and ranking by category.

of academic evaluation, and shifting the emphasis from the quantity of papers to the quality of scientific research results, and from the country, impact factor, and journal rank of the published papers to the innovation and social value of the papers themselves[254]."

The goal is to build a new publication platform with social recognition and international and national influence based on the results of the evaluation of high-quality science and technology journals and to address the direct needs of the management of science and technology journals, in general, and scientific research evaluation work, in particular. The F5000 platform, which focuses on top-level academic papers published in China's leading scientific journals, is intended to be not only a useful tool for scientific evaluation but also a new way to conduct research management, science and technology policy, and related research. For example, CITIC has partnered with CoreView (formerly Thomson Reuters Group) to provide links to data on F5000 papers cited in SCI papers. CITIC and Taylor & Francis Group have collaborated to analyze the international research behavior of F5000 high-impact authors based on their data resources to increase the influence of F5000 authors in the international academic community. Moreover, CITIC and Trend MD Canada have collaborated to recommend 5000 papers from 994 journals published by internationally renowned publishers, including the *Proceedings of the National Academy of Sciences of America* (PNAS). To enhance science and technology cooperation between China and Japan and to deepen understanding of the status and trends of mutual influence of top-level scientific achievements between the two countries, CITIC has collaborated with JST in the F5000 project to exchange and share F5000 papers and citation information with JST's J-stage in Japanese and Chinese. Since January 2015, CAST has published a "Chinese Journal Digest" of papers selected for the F5000 project by discipline with the aim of jointly increasing the impact of excellent Chinese papers and high-quality journals. In 2019, CITIC also collaborated with the Tencent Foundation and nominated F5000 authors for the Science Discovery Award, and four of the F5000 authors received the Science Discovery Award[255]. In addition, in cooperation with Wiley Publishing Group, F5000 platform authors were recommended as editorial board members and reviewers for journals. ISTIC further conducts a comprehensive evaluation of the F5000 nominated papers and, based on the results of quantitative analysis and peer review, announces the "Frontrunner 5000" award at the following year's China Science and Technology Paper Statistics Conference.

The mechanism for selecting individual papers for the F5000 is roughly as described above based on scientific indicators such as citation frequency over a certain period of time and the peer review system. The format in which the papers are actually published on the platform is outlined below.

Publication requires an English abstract of at least 1,000 words, which should include the study's purpose, methodology, methods (theory, conditions, materials, etc.), results, and conclusions. The abstract should focus, in particular, on the innovativeness of the paper to emphasize originality, rather than merely serve as an introduction. Interestingly, authors are cautioned not to make subjective comments in the paper or exaggerate the value of their findings. There are also detailed instructions for the use of abbreviations, product names, and personal names. These conditions are intended to prevent linguistic problems with retrieval, and they demonstrate attention to detail. These

254 Pan Yuntao, Ma Zheng, Su Cheng, Zhang Yuhua, Guo Yu, Yuan Junpeng, Guo Hong, Yu Zhenglu, Zhai Lihua, Xu Bo, Jia Jia, Gao Jiping, Wang Haiyan, Tian Ruiqiang,《F5000论文遴选方法与过程分析潘》(Analysis on the selection method of F5000 from ISTIC), www.cjstp.cn/article/2016/1001-7143/1001-7143-27-8-811.shtml (accessed September 5, 2021)

255 《中国组织工程研究》杂志入选2020年度F5000论文12篇, August 15, 2021, 10:16:41 HKT https://inf.news/science/a1a5f8ef0b07b0ed1400cbb3e73a3ae0.html (accessed August 15, 2021) (based on a DeepL translation)

measures raise the international visibility of papers and coordinate searches for literature and international citations on the same platform.

As described above, the F5000 platform is a database of approximately 5,000 papers from outstanding Chinese journals, which are centrally linked and disseminated to international peers with the cooperation of international information service organizations and international publishers. In addition, by providing English abstracts for papers published in Chinese, the platform functions as an efficient channel for disseminating these papers around the world and for integrating Chinese-language academic journals with the international academic community. The F5000 platform has been searched 694.89 million times and accessed by international users from more than 140 countries, including the U.S., Canada, the United Kingdom, Japan, Germany, France, and South Korea, with more than 200,000 accesses from the U.S[256]. In 2019, the F5000 platform attracted the interest of international academic journals, with links from 826 journal sites, including *Science*. The platform also has an award program for featured researchers[257].

4.4.2 Chinese paper databases' position in the world and future goals

The Chinese Science and Technology Paper and Citation Database was established in 1987 and has been in operation ever since. The Highest National Science and Technology Award given to selected journals was established in 2008, and the selection process has occurred every three years since then. The F5000 platform was launched in 2012. Moreover, in January 2020, the Action Plan for the Excellence of Chinese STM Journals was launched. These and other policies to advance and internationalize journals have been implemented over time. In addition, some universities, scientific research institutes, and journals may publicize on their websites that they have received the Highest National Science and Technology Award or that their papers have been selected and published on the F5000 platform to promote their own achievements[258].

Figure 9 illustrates the overall situation shaped by China's creation of its own Chinese world-leading journals through the above process. China aims to foster and develop excellent journals as a stage for 1.8 million Chinese researchers to compete for originality, select outstanding Chinese-language journals among them, aggregate selected papers on the F5000 platform, publish long abstracts in English, and link them to databases around the world to "visualize" and demonstrate leadership in the field. Furthermore, through the development of these Chinese journals, China intends to encourage researchers around the world to submit their papers to Chinese journals, and to set a world-leading standard in science. This means moving away from the world of SCI, which has been created with Western, market-oriented standards, and measure excellence with Chinese-led standards. In this world, it may be

256 《中国科技论文整体表现如何？ 最新报告来了》,2020年12月29日 15:58 来源：经济日报-中国经济网, http://www.ce.cn/xwzx/kj/202012/29/t20201229_36169097.shtml (accessed August 15, 2021). According to this article, international users are mainly international universities, including Cornell University and Harvard University in the U.S. and University of Cambridge, University College London, and University of Oxford in the United Kingdom, as well as research institutions like Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, and Argonne National Laboratory in the U.S. The F5000 platform has also been published in 994 international journals, including SCIENCE, Proceedings of the National Academy of Sciences (PNAS), and Journal of the American Medical Association (JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION) (the above is based on a DeepL translation).

257 [19-008] Summary of China Science and Technology Paper Statistics 2019 edition, JST Pekin Tayori, JST Beijing Office, November 25, 2019, https://spc.jst.go.jp/experiences/beijing/bj19_008.html (accessed August 10, 2021)

258 For example,《中草藥》入選2015, 2016年度F5000論文各22篇, February 7, 2021, Journal of Chinese Herbal Medicine, https://ppfocus.com/0/ed17676ac.html (accessed August 15, 2021) (based on a DeepL translation)

possible to motivate Chinese researchers to "improve the quality of research" and hopefully stimulate the creation of originality and even to attract researchers from other countries. Quality will not be measured as it currently is, based on external standards such as SCI papers, the number of citations within those papers, or FWCI but using independent standards that allow China to demonstrate its own excellence.

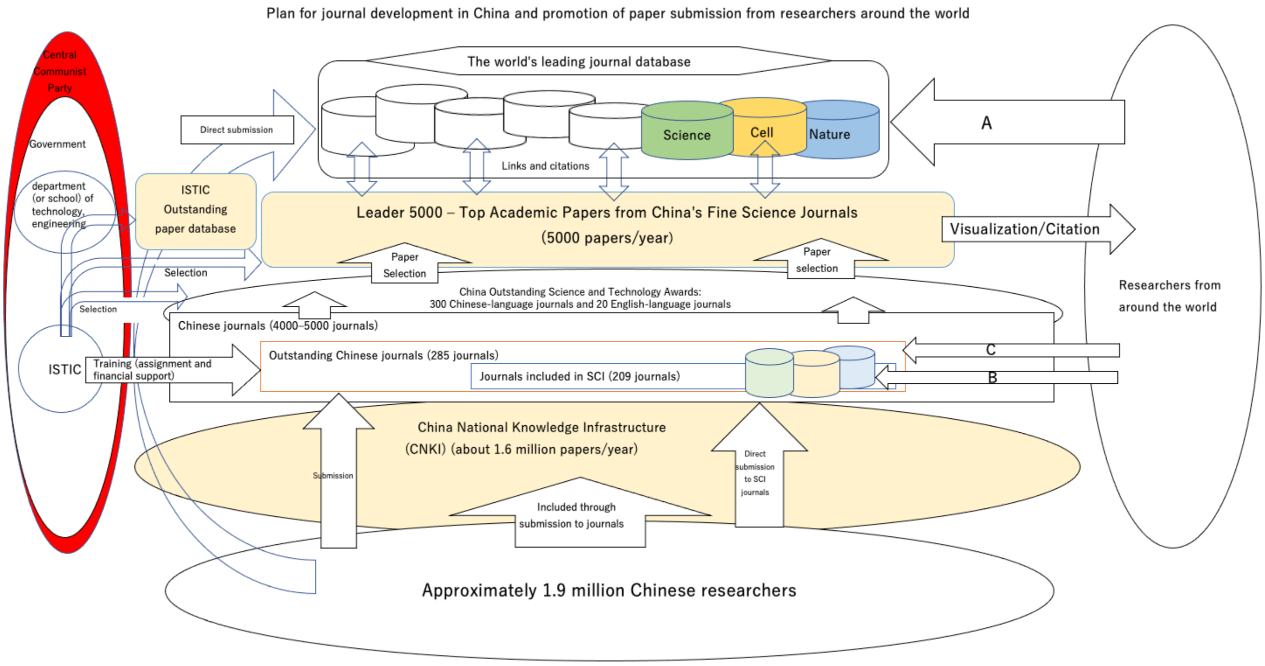


Figure 9: Plan for journal development in China and promotion of paper submission from researchers worldwide

Source: Prepared by the authors based on information from various sources[259]

This may be because, as China thoroughly pursued a policy of shifting the focus from the quantity to the quality of papers and eliminating competition for SCI papers, it was necessary to provide an alternative arena for competition. China has shown a willingness to develop methods for evaluating research results based on quality rather than quantity while absorbing the know-how of advanced journal management organizations in the West and is implementing these methods. The goal of this approach seems to be to map the world by Chinese standards and even attract Western researchers to the Chinese-led arena.

In the 13th Five-Year Plan, China clearly expressed its policy to strengthen its own institutional hegemony ("structural power" as a concept in international political science) using the concept of "institutional discourse

259 Note: Arrow A indicates the central flow of submissions by world scientists; arrow B indicates the same flow as arrow A above, specifically for SCI journals; and arrow C indicates the future flow of submissions by world scientists that China is expecting.

power," that is, "a country's power to create an international regime as a set of norms and rules to be followed[260]." Accordingly, China may be trying to secure "structural power" in the world of scientific journals, as well. The reality is that journals have existed for more than 100 years, and today, a handful of companies "control" the publication, release, and evaluation of many papers, and researchers are competing with each other in this world. China seems intentioned to change this situation in a way that will allow it to exert its power. In the future, the question will be how Japanese, European, and U.S. researchers will respond to the editing of Chinese journals once they understand such policy intentions. From a critical point of view, it is expected that evaluations based on the number of citations will not necessarily remain high in the future, whereas cross-citations among researchers within China will be highly effective. Therefore, Chinese researchers may be required to develop their own standards of evaluation and understand them fully.

Let us consider the results of the journal policy revision. Although the revision had various effects, the top 10 research institutions in the Nature Index Annual Tables 2021 changed, with top-10 Chinese institutions dropping from 7 in the previous year's list to 2 in 2021[261]. Professor Futao Huang from the Research Institute for Higher Education, Hiroshima University believes that this change is due to the August 16, 2019, "Opinions on deepening reform to cultivate world-class STM journals" (see above) by the Chinese Association for Science and Technology, the Central Propaganda Department of the Communist Party of China, the Ministry of Education, and the Ministry of Science and Technology.

4.5 Chinese scientific papers

In this section, we will attempt to develop a perspective on how to evaluate the current status and future of Chinese scientific papers, which are developing with such momentum as to be approaching and surpassing the U.S. in both quantity and quality. As we take a closer look at basic research promotion and scientific research management reform in China, it is extremely important to consider the quantity and quality of the papers that are the result of that research.

4.5.1 Number of Chinese papers

The growth in the number of Chinese scientific papers (below, "papers") over the past decade or more has been remarkable, and significant breakthroughs have been made. The exact number of papers is difficult to determine, as the count varies from database to database in terms of the type and number of target journals and the use of the

260 "Why China is determined to achieve technological hegemony: Deciphering national strategy," Kamo Tomoki, Professor, Faculty of Policy Management, Keio University, January 18, 2021, Science and Technology Topic No. 172, Science Portal China, Japan Science and Technology Agency, https:// spc.jst.go.jp/hottopics/2101/r2101_kamo.html (accessed December 18, 2021). Aside from the world of scientific journals, as implied in the 14th Five-Year Plan, China is also launching an initiative to bring together scientists from around the world by creating an international science and technology fund. This, too, may be seen as an attempt to follow the example of the Asian Infrastructure Investment Bank (AIIB) to achieve hegemony in scientific and technological innovation.

261 "Ten rising stars of the Nature Index Annual Tables 2021," Nature, 20 May 2021, https://www.natureindex.com/news-blog/ten-rising-stars-institutions-of-nature-index-annual-tables-twenty-twenty-one (accessed August 9, 2021). According to this article, in the 2020 ranking (2018-2019), the University of Science and Technology of China, University of Chinese Academy of Sciences, Sun Yat-sen University, and Jilin University occupied the first four positions, followed by Nankai University, Huazhong University of Science and Technology, and Tianjin University in sixth, seventh, and eighth positions, respectively. In contrast, the 2021 ranking (2019-2020) only includes the Southern University of Science and Technology (No. 1) and Shanghai Jiao Tong University (No. 4).

fractional or integer method. In addition, several Chinese institutions publish their own statistics on papers, and it is not easy for those who analyze and evaluate them to understand them in a consistent manner. One source also notes that “there is considerable overlap between the journals included in several academic literature databases[262].” This indicates that a great deal of caution is required on the part of those conducting the analysis and evaluation.

According to the Web of Science (WoS), in 2018, the number of papers worldwide was about 1.6 million[263], and the number of Chinese papers (calculated using the integer method) was 397,000. According to Scopus, the number of Chinese papers was 305,900[264]. According to the China National Knowledge Infrastructure (CNKI) database[265], the number of papers in all Chinese domestic and international databases, including papers written in Chinese, was estimated to be 1,535,000[266]. Based on these data, we can assume that the most recent number papers in China is roughly 400,000. Below is the number of papers based on several databases published by China. Before we begin, it should be noted that China uses its own definitions of “excellence” and “superiority” to select and compile these databases. It is difficult to determine whether the compiled results should always be taken as an indication of a certain level of research ability.

The number of papers according to the National Institute of Science and Technology Policy (NISTEP) of MEXT is as shown above. However, the number of “excellent papers[267]” in 2020, announced in December 2021 by ISTIC under the jurisdiction of China’s Ministry of Science and Technology, is 216,000 international papers and 247,800 domestic papers, totaling 463,800[268].

As for the number of papers published in SCI-indexed journals, according to the “2019 Statistical Analysis of Chinese Science and Technology Papers” published by the Ministry of Science and Technology in 2021, in 2019, the number of science and technology papers published in China was 448,000 in domestic journals and 496,000 in SCI-

262 Sawada Yuko and Kano Shuji (JETRO Institute of Developing Economies, Library), “Visualizing China’s Research Power: Development and Initiatives of Domestic Academic Literature Databases,” Ajiken World Trend No. 259 (2017. 5), file:///C:/Users/ takayuki.shirao.kf/Desktop/%E3%82%A2%E3%82%B8%E3%82%A2%E5%A4%AA%E5%B9%B3%E6%B4%8B%E3%82%BB%E3%83%B3%E3%82%BF%E3%83%BC/%E4%B8%AD%E5 %9B%BD/%E7%89%B9%E5%AE%9A%E8%AA%B2%E9%A1%8C/%E3%82%B8%E3%83%A3%E3%83%BC%E3%83%8A%E3%83%AB/ZWT201705_008%20(2).pdf (accessed January 19, 2022)

263 From the Japanese Science and Technology Indicators 2020 (HTML version) statistical collection. https://www.nistep.go.jp/sti_indicator/2020/RM295_table.html (accessed August 9, 2021). Compiled by the National Institute of Science and Technology Policy based on Clarivate Analytics Web of Science XML (SCIE, late 2019 version).

264 “China overtakes U.S. for first place in number of papers, Japan drops to fourth, but maintains top spot in number of patent applications,” JST Science Portal, August 12, 2020, https://scienceportal.jst.go.jp/newsflash/20200812_01/ (accessed August 9, 2021)

265 The China National Knowledge Infrastructure (CNKI) is a Chinese comprehensive academic information database established in 1996 by Tsinghua University. It contains various databases of academic journals, important newspapers, doctoral dissertations and theses, and academic conference papers. China Academic Journals (CAJ) contains papers published in approximately 10,000 Chinese academic journals. The subject areas cover all academic fields: mathematical sciences; chemistry, chemical industry, and energy; industrial technology; agriculture; medicine and hygiene; literature, history, and philosophy; politics, economics, and law; education and social sciences in central; and electronics and information sciences (the above information is from the Research Navi of the Japanese National Diet Library).

266 According to the JST Beijing Office, this information was presented by Chinese scientist Yang Wei at the World Journal Summit during the CAST Annual Meeting in August 2020. However, the same CNKI data shows a figure of about 1.6 million papers (2016) (see section 4.5.8).

267 Excellent papers are papers included in the “China excellent science and technology paper databases.” They are international papers that exceed the average number of citations and domestic papers that are published in core journals in CSTPD and exceed the desired value of the cumulative citation timeline index in their field (papers that have been cited n times or more in n years after publication).

268 2021年中国科技论文统计报告发布稿, https://www.istic.ac.cn/isticcms/html/1/284/338/6905.html (accessed January 11, 2022)

indexed journals[269], accounting for 21.5% of all SCI-indexed papers worldwide in 2019[270]. In 2020, the number of papers was 552,600, an 11.4% increase from 2019 and nearly double the 361,200 papers in 2017. In 2020, Chinese papers accounted for 23.7% of SCI-indexed papers, with a steady increase from 18.6% in 2017.

Statistics on Chinese papers in domestic journals comprise papers with Chinese researchers as first authors in 2,084 natural science journals included in CSTPSD[271]. A total of 2,070 journals and 447,800 papers were recorded in 2019, and 451,600 papers were recorded in 2020.

The number of papers published in top-class journals[272] worldwide is also calculated and published by ISTIC and others. However, because there is no consistency in how top-class journals are selected, this information is only given for reference here. Incidentally, China ranked second after the U.S. for the number of papers published in top-class journals, with 1,833 papers out of 25,454.

In addition to the above, China has published a number of "international hot papers[273]." The number of these papers increased from 842 in 2017 (27.6%, ranking third worldwide; 1,629 in the U.S) to 1,056 in 2018 (32.6%, ranking second; 1,562 in the U.S), and then to 1,375 in 2019 and 1,515 in 2020, accounting for 36.3% of the world total and ranking second worldwide (the U.S. ranked first with 1,751 papers).

For the past few years, China has remained in fourth place worldwide for the number of papers published in *Science*, *Nature*, and *Cell*, which can be used as an indication of ability independent of the number of citations. The number of Chinese papers published in these journals was 309 out of 5,697 in 2017 (ranking fourth); 429 out of 6,641 in 2018 (same); 425 out of 6,456 in 2019 (same); and 516 out of 6,103 in 2020 (same)[274] .

ISTIC's publication aggregates the number of papers in journals with the highest impact factor in each field. In 2018, the total number of papers published in these 155 was 61,420, of which 11,318 were Chinese papers (an increase of 3,059 papers). Chinese papers ranked second worldwide with 18.4% of the total (7,574 papers, or 66.9%, were reportedly supported by the NSFC). The U.S. accounted for 22,017 papers, or 35.8%. In 2019, the total number of papers was 58,290, of which 13,068 were Chinese papers (an increase of 1,750 papers). Chinese papers ranked second worldwide with 22.4%, of the total (9,198 papers, or 70.4%, were reportedly supported by the NSFC). The U.S. accounted for 19,561 papers, or 33.6%. In 2020, the total number of papers was 56,433, of which 12,171 were Chinese papers. Chinese papers ranked second worldwide with 21.6% of the total (8,065 papers, or 66.3%, were reportedly supported by the NSFC). The U.S. accounted for 17,154 papers, or 30.4%.

269 [[21-045] Ministry of Science and Technology Announces "2019 Statistical Analysis of Chinese Science and Technology Papers"], JST Beijing Office, August 04, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_045.html (accessed August 11, 2021).

270 Based on this ratio, the total number of SCI papers worldwide in 2019 would be approximately 2.3 million.

271 The Chinese Science and Technology Paper and Citation Database (CSTPCD, in Chinese: 中国科技论文统计与分析数据库), widely known as a statistical and analytical database of Chinese science and technology papers, is the Chinese version of the Science Citation Index and is part of the ISTIC project. The journals included in CSTPCD are core journals in the field of science and technology in China, and their current OA status is said to reflect the OA trend of Chinese science and technology journals (Li Ying, Tian Ruiqiang, "CA1909 - Open Access Initiatives and the Actual Status of Science and Technology Journals in China," Current Awareness Portal, No. 334 December 20, 2017 (https://current.ndl.go.jp/ca1909 accessed January 11, 2022).

272 Since 2017, the number of top-class journals increased from 7 to 15, and the standard for selecting these journals changed, from an impact factor of 35 or more to an impact factor of 30 or more.

273 The papers must have been published in *Nature*, *Science*, *New England Journal of Medicine*, *Cell*, *Chemical Reviews*, *Journal of the American Medical Association*, or *Chemical Society Reviews* in the last two years; cited extensively in the last two months; and among the top 1% of citations in the respective fields.

274 In 2020, the U.S. published 2,478 papers in *Science*, *Nature*, and *Cell*, ranking first in the world.

The following figure shows the results of a tally of papers[275] based on Scopus published annually by the U.S. NSF.

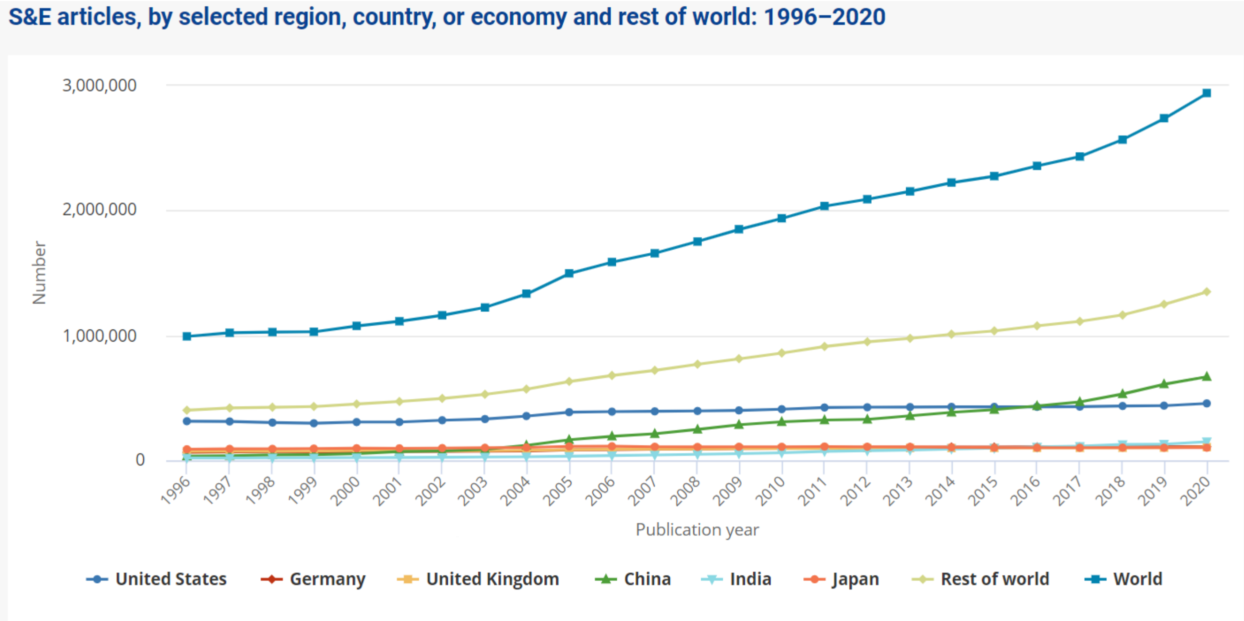


Figure 10: Trends in number of S&E articles based on Scopus

Source: NSF Science & Engineering Indicator 2020

S&E articles in all fields for 15 largest producing regions, countries, or economies: 2010 and 2020

(Number and percent)

Rank	Region, country, or economy	2010	2020	2020 world total (%)	2020 cumulative total (%)
na	World	1,938,121	2,940,807	na	na
1	China	308,769	669,744	22.77	22.77
2	United States	409,512	455,856	15.50	38.28
3	India	60,555	149,213	5.07	43.35
4	Germany	97,255	109,379	3.72	47.07
5	United Kingdom	94,081	105,564	3.59	50.66
6	Japan	108,534	101,014	3.43	54.09
7	Russia	33,855	89,967	3.06	57.15
8	Italy	58,252	85,419	2.90	60.06
9	South Korea	50,224	72,490	2.46	62.52
10	Brazil	41,501	70,292	2.39	64.91
11	France	68,300	66,479	2.26	67.17
12	Canada	56,445	65,822	2.24	69.41
13	Spain	49,031	65,638	2.23	71.64
14	Australia	41,661	60,891	2.07	73.71
15	Iran	24,694	57,755	1.96	75.68

na = not applicable.

Figure 11: Growth in number of S&E articles from 2010 to 2020

Source: NSF Science & Engineering Indicator 2020

[275] NSF, Science & Engineering Index, "Publications Output:. U.S. Trends and International Comparisons," https://ncses.nsf.gov/pubs/nsb20214/publication-output-by-country-region-or- economy-and-scientific-field (accessed January 13, 2022): Article counts refer to publications from a selection of conference proceedings and peer-reviewed journals in S&E fields from Scopus. Articles are classified by their year of publication and are assigned to a region, country, or economy on the basis of the institutional address(es) of the author(s) listed in the article. Articles are credited on a fractional count basis (i.e., for articles produced by authors from different countries, each country receives fractional credit on the basis of the proportion of its participating authors).

Another example of the growth in the number of Chinese papers[276] is the fact that the average number of papers increased by about 5 times in the 10 years between 1995-1997 and 2015-2017. Although it is true that the number of Chinese papers has continued to increase, the papers themselves range from those written in Chinese with English abstracts to those written entirely in English, and some papers are said to be written in Chinese and English with the same content. We believe it is necessary to analyze specifically what types of papers are included in bibliographic databases. However, this aspect has yet to be investigated in depth at this point in time.

Another indicator is the number of papers designated as "high-level international journal papers," that is, the number of papers published in the top 10% of journals in each field in terms of impact factor and total citations, which are referred to as "high-quality international papers." According to this source, in 2020, the total number of papers published in 395 target journals was 209,301, of which 65,995 (31.5%) were from China, ranking first worldwide[277]. The United States published 40,865 papers (19.5%).

Data show that more than 12% of Chinese papers are produced by researchers returning from abroad, and some estimates suggest that the actual figure may be much higher[278]. Similarly, the proportion of high-impact papers among the writings of researchers who returned from abroad is higher than for those who continued their research in China.

4.5.2 Number of citations of Chinese papers

Meanwhile, the number of citations of Chinese papers is said to have risen to the second place in the world between 2007 and 2017. This means that China has achieved the goal of becoming one of the top five most cited countries in the world, as stated in the National Medium- and Long-Term Program for Science and Technology Development for 2006-2020 (国家中长期科学和技术发展规划纲要) even before the term set in the plan. China is ranked in the top 10 for 18 academic fields, and in the top three in many fields. In 2016, China ranked third in the world for the number of highly cited researchers, with 183 researchers (including Hong Kong, Macau, and Taiwan)[279]. The number of papers increased from 120,000 in 2009 to 426,000 in 2016 and 450,000 in 2019[280]. That same year, China ranked second after the U.S. in the list of highly cited researchers compiled by WoS. The annual list of authors of highly cited papers published by Clarivate Analytics also shows a growing trend of Chinese researchers, with 636 (10.2%) out of a total of 6,217 in 2019 and 770 (12.1%) out of a total of 6,167 in 2020 (the U.S. ranked first in both years). As for research institutions, only CAS was ranked in the top 10 in 2019, whereas Tsinghua University was ranked in the top 10 in

276 Indicators of Science and Technology, 2019 edition, p. 84, https://www.mext.go.jp/content/20200420-mxt_chousei01-20200420113803_5.pdf (accessed June 8, 2021)

277 By way of comparison, in 2019, there were 394 target journals, and China ranked second worldwide with 190,661 papers.

278 "Returning Scientists and the Emergence of China's Science System", Forthcoming, Science and Public Policy Journal, 5 December 2019: Cong Cao, Faculty of Business, The University of Nottingham Ningbo China, Jeroen Baas, Elsevier B.V. Registered Office, Caroline S. Wagner, John Glenn College of Public Affairs, The Ohio State University, Koen Jonkers, European Commission, Joint Research Centre https://academic.oup.com/spp/article/47/2/172/5658550 (accessed December 16, 2021)

279 Wei Huang, "Advancing basic research towards making China a world leader in science and technology," National Science Review, Volume 5, Issue 2, March 2018, Pages 126-128, https://academic.oup.com/nsr/article/5/2/126/4816745 (accessed June 22, 2021)

280 Smriti Mallapaty, "China bans cash rewards for publishing papers", Nature, NEWS 28 February 2020, https://www.nature.com/articles/d41586-020-00574-8 (accessed June 22, 2021)

2020[281]. According to other data[282], from 2011 to October 2021, Chinese researchers published a total of 3,365,900 international papers, and their total number of citations was 43,328,000 (20.2% more than the previous year), ranking second in the world, with a steady increase in both figures. The number of citations per paper also increased to 11.94 in 2019, up from 10.92 the previous year. However, this number was lower than the global average of 13.26 citations. In data focusing specifically on "highly cited papers[283]," from 2011 to 2021 (through September), China accounted for 42,902 papers, or 24.8% of the total, in the top 1% of papers for citations in each field worldwide (the U.S. ranked first with 77,068 papers, or 44.5%).

As for the number of citations, the percentage of papers that received no citations in the first three years after publication was 44.6% for CNKI and 29.0% for Scopus. As already mentioned above, the reality is that submission to English-language journals is strongly encouraged at Chinese universities.

4.5.3 International coauthorship of Chinese papers

China's international coauthorship rate increased from an average of 22.3% in 2007-2009 to an average of 26.6% in 2017-2019. Likewise, international coauthorship[284] increased to an average of 107,801 papers in 2017-2019, ranking second after the United States. China is now the number one partner in coauthored U.S. papers (2017-2019 average), and its share has increased from an average of 24.3% in 2007-2009 to an average of 27.4% in 2017-2019. The number of internationally coauthored papers in China based on SCI-indexed journals has reached 144,500 in 2020, up 11.1% from 130,100 the previous year. The number of papers with a Chinese researcher as the first author is 69.3% (as of 2020) and has remained around 70% for the last few years[285]. Furthermore, according to the Scopus-based statistics in the field of science and engineering (S&E) published annually by the U.S. NSF[286], the number of internationally coauthored papers was 163,200, and the number of domestic papers was 574,700 (both calculated using the integer method). The percentage of internationally coauthored papers was, therefore, 22.1%. This percentage is low compared to the global average of about 35% international coauthorship. This percentage has increased slightly from 20.47% in 2016 but appears to be headed toward somewhat of a plateau. Future trends will be closely observed.

281 Tadamichi Koiwai, "[20-32] China's number of highly cited paper authors continues to increase, and Tsinghua University enters the top ten of affiliated institutions for the first time," JST Science Portal China, Interview Report, December 14, 2020, https://spc.jst.go.jp/experiences/coverage/ coverage_2032.html (accessed August 12, 2021), [[19-32] China rises to second place for the number of highly cited paper authors: Clarivate Analytics analysis], JST Science Portal China, Press Report, November 22, 2019, https://spc.jst. go.jp/experiences/coverage/coverage_1932.html (same as above).

282 [21-045] Ministry of Science and Technology Releases "2019 Statistical Analysis of Chinese Science and Technology Papers," Pekin Tayori, JST Beijing Office, August 04, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_045.html (accessed January 12, 2022), etc.

283 Beijing Office information (December 28, 2021)

284 National Institute of Science and Technology Policy, "Benchmarking Scientific Research 2021 [Research Material - 312]," https://www.nistep.go.jp/research/science-and-technology-indicators-and-scientometrics/benchmark (accessed August 12, 2021).

285 Pekin Tayori, *op. cit.*

286 NSF Science & Engineering Indicator, https://ncses.nsf.gov/pubs/nsb20214/international-collaboration-and-citations (accessed January 12, 2022)

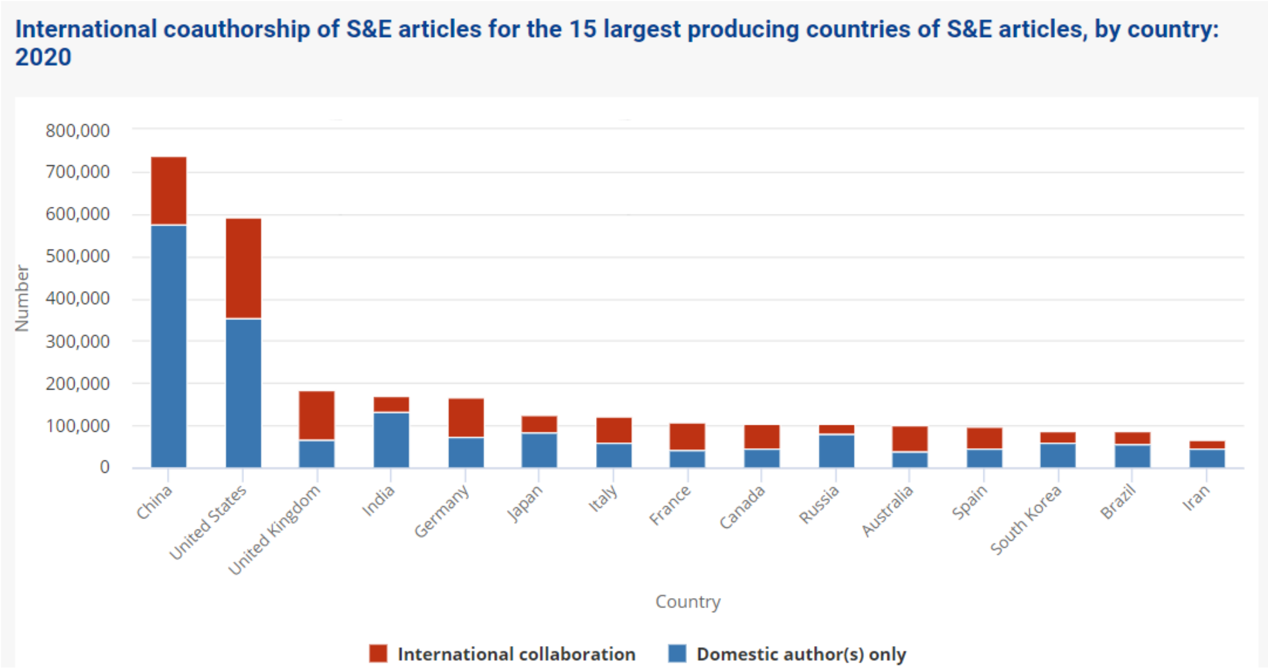


Figure 12: Number of coauthored S&E papers for the 15 largest producing countries, 2020

Source: NSF Science & Engineering Indicator

Meanwhile, the most instances of coauthorship continues to be by Chinese and American scholars, with the share increasing from an average of 40.8% in 2007-2009 to an average of 44.5% in 2017-2019[287]. From 2015 to 2020, the number of papers coauthored by U.S. and Chinese researchers increased from 3,412 to 5,213, whereas the growth rate is said to have leveled off since 2018[288]. It will be interesting to see how the coauthorship rate of Chinese papers with the U.S. will be affected by future changes in U.S. policy toward China.

The coauthorship rate of Chinese domestic researchers with research experience abroad accounts for 27% to 29% of all internationally coauthored papers and is double the rate of those without experience abroad. The international relationships and networks of those with research experience abroad are believed to contribute to this phenomenon. Production of papers by returning researchers is also strong. In 2017, 27% of China's international papers were authored by returning researchers, of which 16% by returnees from the U.S. and EU and 11% by returnees from other countries and regions. Furthermore, Chinese researchers who are long-term residents of the U.S. and EU have contributed to the writing of papers in collaboration with mainland Chinese researchers. In 2017, internationally coauthored papers written with Chinese researchers residing in the U.S. and EU accounted for 8% and 5%, respectively, of all internationally coauthored papers in China. From 2005 to 2017, the number of papers coauthored by Chinese researchers who went from China to the U.S. or EU with researchers from the respective country or region increased slightly or remained at about the same level, from 21% to 24% and from 10% to 9%, respectively.

287 Nishikawa Kai, Kurogi Yutaro and Igami Masatsura, Research Material-312 "Benchmarking of Scientific Research 2021: Bibliometric Analysis on Dynamic Alteration of Research Activity in the World and Japan," p. 47, August 2021, Center for S&T Foresight and Indicators, National Institute of Science and Technology Policy, https://www.nistep.go .jp/wp/wp-content/uploads/NISTEP-RM312-FullJ.pdf (accessed August 12, 2021)

288 James Mitchell Crow, "US-China partnerships bring strength in numbers to big science projects," NATURE INDEX 09 March 2022, https://www.nature.com/articles/d41586-022-00570-0 (accessed 4 May 2022)

Meanwhile, the number of papers coauthored by Chinese researchers who returned to China from the U.S. or EU with the respective country or region decreased slightly, from 20% to 18% and from 5% to 3%, respectively[289].

According to data on internationally coauthored papers from ISTIC's "China excellent science and technology paper databases[290]," the number of internationally coauthored papers was 110,800 in 2018, 130,000 in 2019, and 144,500 in 2020, with an increase of 14,400 papers. The ratio to the total number of papers published in China was exactly the same, 26.2%, in both 2019 and 2020.

Table 5: Share of number of papers and share of number of citations

All fields	1995–1997 (PY) (Average)		
	Number of papers		
Country or region	Fractional count		
	Papers	Share	Rank
U.S.	196,528	29.6	1
Japan	56,203	8.5	2
U.K.	48,036	7.2	3
Germany	45,730	6.9	4
France	34,698	5.2	5
Canada	24,618	3.7	6
Russia	22,881	3.4	7
Italy	21,963	3.3	8
China	14,621	2.2	9
Australia	14,122	2.1	10

All fields	2015–2017 (PY) (Average)		
	Number of papers		
Country or region	Fractional count		
	Papers	Share	Rank
U.S.	276,638	18.8	1
China	272,698	18.6	2
Germany	66,110	4.5	3
Japan	63,725	4.3	4
U.K.	61,003	4.2	5
India	55,707	3.8	6
Korea	47,642	3.2	7
France	45,520	3.1	8
Italy	45,207	3.1	9
Canada	40,108	2.7	10

All fields	1995–1997 (PY) (Average)		
	Number of adjusted top 10% papers		
Country or region	Fractional count		
	Papers	Share	Rank
U.S.	29,957	45.1	1
U.K.	5,556	8.4	2
Germany	4,231	6.4	3
Japan	3,939	5.9	4
France	3,188	4.8	5
Canada	2,879	4.3	6
Italy	1,787	2.7	7
Netherlands	1,655	2.5	8
Australia	1,440	2.2	9
Sweden	1,194	1.8	10

All fields	2015–2017 (PY) (Average)		
	Number of adjusted top 10% papers		
Country or region	Fractional count		
	Papers	Share	Rank
U.S.	38,347	26.1	1
China	28,386	19.3	2
U.K.	8,718	5.9	3
Germany	7,591	5.2	4
Italy	5,014	3.4	5
France	4,716	3.2	6
Australia	4,530	3.1	7
Canada	4,455	3.0	8
Japan	3,927	2.7	9
Spain	3,542	2.4	10

(Source: Processed and prepared by MEXT based on MEXT National Institute of Science and Technology Policy, "Indicators of Science and Technology, 2019 Edition")

The number of internationally coauthored papers whose first authors were Chinese decreased from 96,000 in 2019 to 101,000 in 2020, and their share of the total decreased from 73.9% to 69.3%. This lack of growth in the number of Chinese first-authored papers or decrease in the number of Chinese first-authored papers as a percentage of

289 "Returning Scientists and the Emergence of China's Science System," Forthcoming, Science and Public Policy. Journal, 05 December 2019: Cong Cao, Faculty of Business, The University of Nottingham Ningbo China, Jeroen Baas, Elsevier B.V. Registered Office Caroline S. Wagner, John Glenn College of Public Affairs, The Ohio State University,Koen Jonkers, European Commission, Joint Research Centre https://academic.oup.com/spp/article/47/2/172/5658550 (accessed December 16, 2021)

290 Quoted from Pekin Tayori

internationally coauthored papers is a very interesting phenomenon.

Table 5 shows the latest rankings for share of papers and share of citations[291]. Figure 13 shows the number of citations and ranking of papers[292].

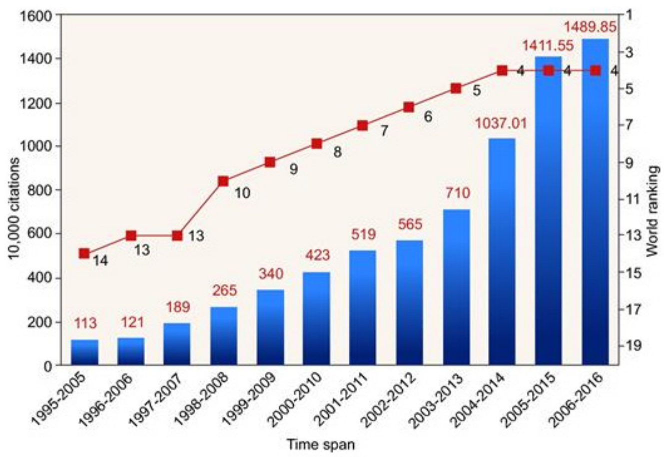


Figure 13: Trends in number of citations and ranking of papers

(Wei Huang, 2018)

4.5.5 Views on the quality of Chinese papers

Statistics on the number and quality of papers are the specialty of Elsevier, Clarivate, and Nature Index. Every year, these sources report on China's rapid progress, focusing on the increase in the number of Chinese papers, China's competition with the U.S. at the top of each field, and paper quality indices including top 10% citations. Meanwhile, in 2019, ISTIC selected 394 international science and technology publications as representative science and technology journals to identify "high-quality papers," that is, papers within the top 10% in terms of impact factor and number of citations. ISTIC selected 190,661 "high-quality papers" from these journals and announced that China ranked second in the world with 59,867 (31.4%) high-quality papers[293] (the U.S. ranked first with 62,717, or 32.9%).

The quality of papers has been the subject of various discussions. It is known that it is not always correct to measure a country's R&D capability based on its number of citations, much less on the impact factor of its journals. Some believe that citations should be used as a reference for quality evaluation overall, while carefully analyzing from which countries or regions the citations originated.

From this perspective, an interesting study is "Characteristics of Paper Publication by Major Countries Focusing on

291 Japanese Science and Technology Indicators 2021, National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology

292 Wei Huang, op. cit.

293 Xinhua News, "China ranks second in the world in number of high-quality international papers," January 4, 2021, 17:16, https://www.afpbb.com/articles/-/3324248 (accessed August 13, 2021)

Journals: Open Access, Publication Countries, and Languages" conducted by NISTEP, MEXT[294]. According to this study, China has a low percentage of citations from foreign countries to its Domestic Non-OA (open access) journals. In other words, the percentage of citations from within China is considerably higher than from other major countries. In fact, the study shows trends in the number of citations from foreign countries to papers published in Foreign Non-OA journals. The average for all papers from Japan, Germany, and France (not including the United States) is 83.4%, compared to 58.7% for China. For the top 10% papers, these values are 87.2% and 61.7%, respectively. These data indicate that Chinese papers have a relatively high rate of domestic citations. Incidentally, in contrast to the number of citations in Foreign Non-OA journals, citations from foreign countries to papers published in Chinese Domestic Non-OA journals are extremely low[295]. Some have argued that a high number of paper citations should not be overestimated[296]. According to a JST/CRDS study, "among winners of 34 prominent international awards, including the Nobel Prize and the Gardner Award, (...) 4 were Japanese, including Professor Yamanaka Shin'ya of Kyoto University, who won the Nobel Prize in Physiology or Medicine." "Even when the selection of awards was broadened to include international academic awards, 31 of the researchers were Japanese, compared to 7 from mainland China." Moreover, "The Thomson Reuters Citation Laureates (published annually since 2002; now taken over by Clarivate Analytics), which is published just before the Nobel Prize winners are announced, is considered an effective source for predicting the Nobel Prize winners. Among the awardees, 7 out of 79 Japanese researchers have won the Nobel Prize thus far, whereas none of the 115 mainland Chinese researchers have ever won[297]." According to the study, that is because "for the vast majority of highly cited scientific papers in China, receiving more citations has become a 'goal in itself'."

The fact that the number of citations does not necessarily reflect the quality of a paper is not only true for China. How the quality of papers should be evaluated is also a more important issue in general[298]. In this regard, it is correct to say that "the game is not about batting average but home runs, especially off-the-field ones." In this sense, the status of contributions to the three journals *Nature*, *Science*, and *Cell* is an important indicator. As mentioned above, the number of Chinese papers in these three journals was 429 out of a total of 6,641 in 2018[299], 425 out of 6456 in 2019,

294 Fukuzawa Naomi, Research Material-254 "Characteristics of Paper Publication by Major Countries Focusing on Journals: Open Access, Publication Countries, and Languages." pp. 34-37, October 2016, Research Unit for Science and Technology Analysis and Indicators, National Institute of Science and Technology Policy, MEXT
https://www.nistep.go.jp/wp/wp-content/uploads/NISTEP-RM254-FullJ.pdf (accessed August 11, 2021)

295 According to the above data, 16.1% of all papers and 23.5% of the top 10% papers.

296 JST/JST China Research Association Report & Materials, 103rd CRCC Research Conference "A Survey of Researchers Who Authored Highly Cited Papers: The Case of Chinese Researchers" (held April 7, 2017), https://spc.jst.go. jp/event/crc_study/study-103.html (accessed August 12, 2021). At the conference, JST/CRDS senior fellow Hayashi Yukihide reaffirmed the survey's conclusion that a high number of citations should not be overestimated and noted that, particularly in China, researchers' difficulty in evaluating each other leaves them with no choice but to rely on quantitative indicators such as the number of papers. Competitive research funds tend to be concentrated on leading researchers, and researchers tend to focus on popular research fields and topics, resulting in a rapid increase in the number of papers. Hayashi also noted that in China, Western-style scientific research has been active only since the end of the Cultural Revolution, and the culture of thoroughly pursuing the truth and respecting science and scientists has not yet fully taken root in society.

297 Higuchi Tadahito, Teraoka Nobuaki, Zhou Shaodan, and Hayashi Yukihide, "Research Report on Researchers Who Authored Highly Cited Papers: The Case of Chinese Researchers," December 2016, Overseas Trends Unit, Center for Research and Development Strategy, National Institute of Science and Technology Policy, https://www.jst.go.jp/ crds/pdf/2016/OR/CRDS-FY2016-OR-02.pdf (accessed August 13, 2021). This report summarizes the results of the research conference mentioned in footnote 170 above.

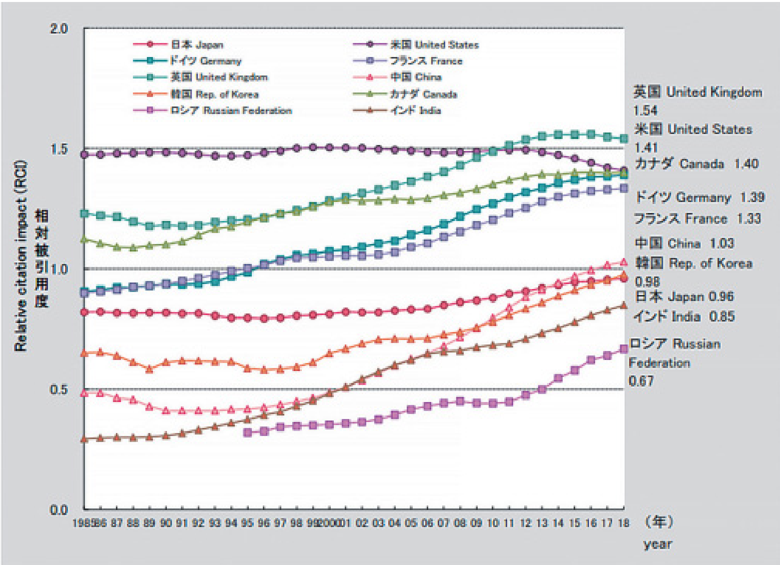
298 China Research and Communication Center, [16-32] "Is China's Research Capability Improvement Genuine?", December 19, 2016, https://spc.jst.go.jp/experiences/coverage/coverage_1632.html (accessed August 11, 2021).

299 *op. cit.*

and 516 out of 6,103 in 2020, consistently ranking fourth worldwide[300].

The Field Weighted Citation Impact (FWCI)[301], which represents the quality of papers, was barely above the average of 1.03 in 2018, as shown in Figure 14[302].

In addition, Nature Index is also cited in Figures 15 and 16[303].



Note: 1. This is a standardized value calculated by dividing the number of citations per paper in each country by the number of citations per paper worldwide (world average = 1.0).
2. Values excluding humanities and social science fields calculated by the Ministry of Education, Culture, Sports, Science and Technology.
3. Values for each year are cumulative over a five-year period; for example, the value for 1985 is the cumulative value for 1981-85.
4. Papers co-authored by multiple countries are counted twice for each country.

Source: Clarivate Analytics, "InCites Benchmarking (Oct 2019)" based on data compiled by the Ministry of Education, Culture, Sports, Science and Technology

Figure 14: Total citations of papers

(FY2020 Indicators of Science and Technology)

300 "China ranks second in the world in the number of high-quality international papers," People's Daily Online, December 30, 2020, 10:55, http://j.people.com.cn/n3/2020/1230/c95952-9804351.html (accessed April 29, 2022)

301 Based on Elsevier's Scopus data, the index is a global average (standard value) of the number of citations of a paper for the same year of publication, field, and type of literature as that paper, with an average value of 1.0. The FWCI makes it possible to compare the impact of papers across different fields and types of literature.

302 Indicators of Science and Technology, 2019 edition, p. 88, https://www.mext.go.jp/content/20200420-mxt_chousei01-20200420113803_5.pdf (accessed June 8, 2021)

303 Hepeng Jia, *op.cit.*

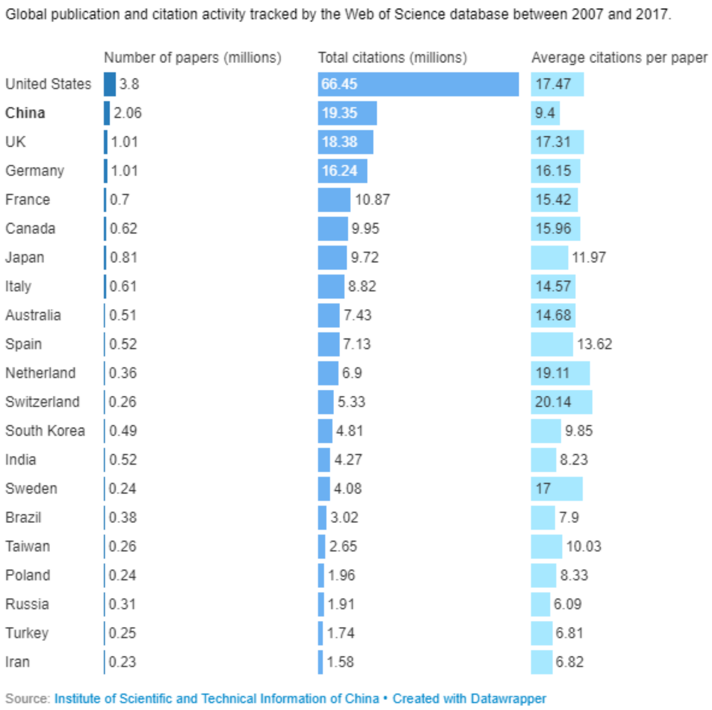


Figure 15: Total number of papers and citations in the WoS database between 2007 and 2017

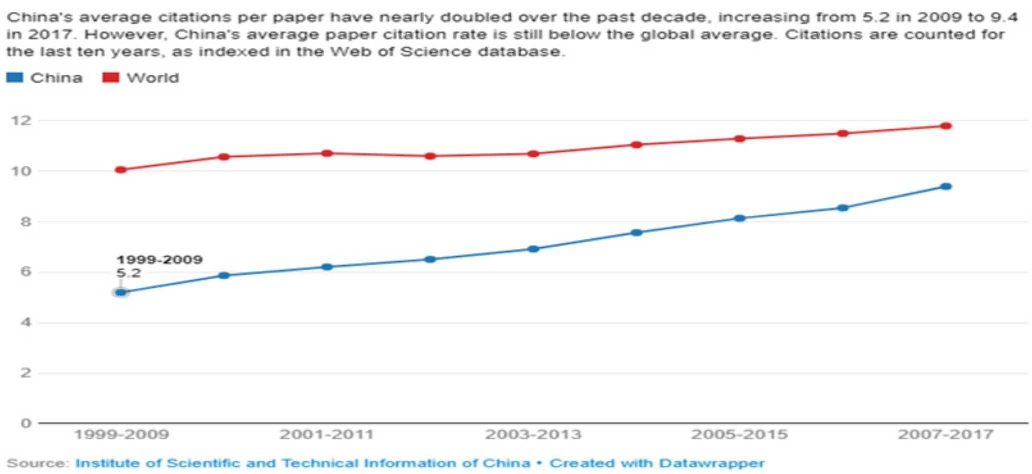


Figure 16: Trends in average citations per paper in China

This increase in China's impact factor cannot be explained simply by the increase in the amount of investment in basic research. Possible explanations include Chinese researchers moving to cutting-edge fields such as nanotechnology and cancer biology, many students becoming researchers and entering the research world, and the efforts of researchers returning from abroad leading to more active international cooperation. Meanwhile, there are also fields and topics such as CRISPR where it is easier to obtain an impact factor, and some universities are concentrating on such research[304].

Figure 17, which compares the influence of the degree of international collaboration on FWCI, clearly shows that China has less international collaboration, which appears to be the cause of its low FWCI[305].

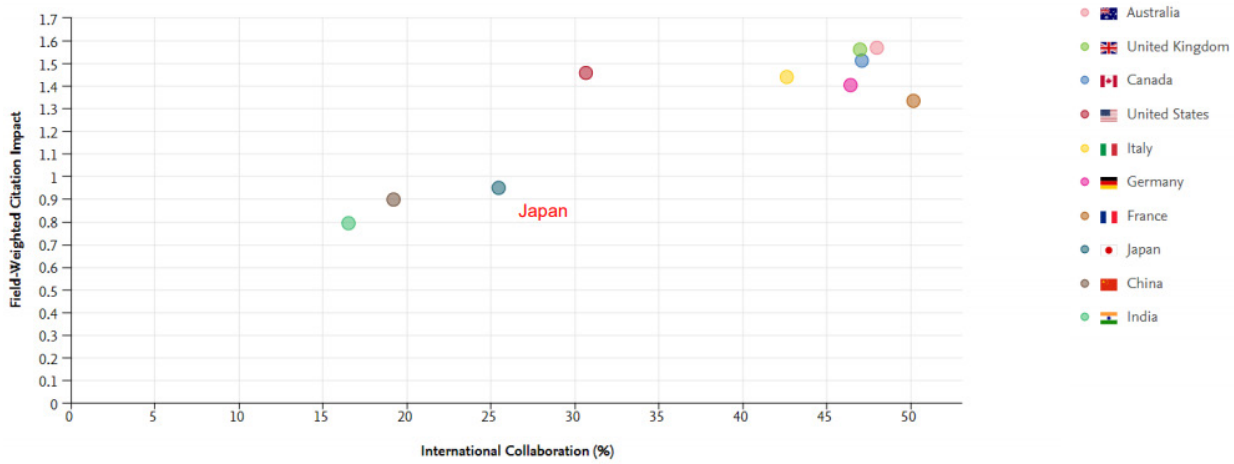


Figure 17: International collaboration rate (horizontal axis) and FWCI (vertical axis)

Source: SciVal, Scopus data, May 13, 2020

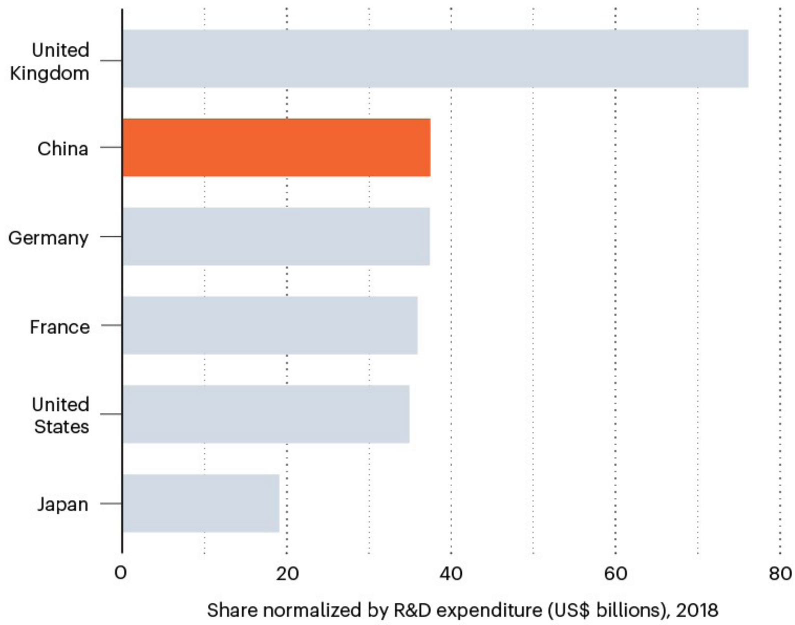


Figure 18: Number of papers per unit investment amount

(From Nature Index, May 26, 2021

304 Hepeng Jia, *op.cit.*

305 Yamauchi Koichi, Customer Consultant, Research Intelligence Division, Elsevier Japan K.K., "SciVal Overview and Indicators," November 2020, https://www.miyazaki-u.ac.jp/ircenter/data/a7905121190704592f4606bb8d09475301b7c6df.pdf (accessed June 8, 2021)

Nevertheless, in 2018, when the 13th Five Year Plan was underway, Times Higher Education's *INSIDE Higher Ed* reported that China's FWCI, which is based on data from Scopus[306], had increased from 0.78 in 2012 to almost 1 in 2017. In the U.S., this index declined from 1.47 to 1.34 over the same time period. The article predicted that, at this rate, China would overtake the U.S. in several fields by the mid-2020s[307]. The article also saw China as "focused on a narrow set of scientific fields geared toward economic growth and geostrategic positioning." ("taking a 'narrow route' to the top").

In terms of rate of paper production per USD 1 billion in 2018, China's index was 37.47, ranking second after the United Kingdom (see Figure 18).

4.5.6 Trends in papers by field

Figure 19 shows trends in the number of papers by major field according to the May 26, 2021, edition of Nature Index[308]. In 2018, China's number of papers calculated using the fractional method overtook the United States in chemistry and was closing in on the United States in geo-environmental and physical sciences. CAS, the University of Science and Technology of China, Peking University, University of Chinese Academy of Sciences, and Tsinghua University accounted for 25% of the total number of papers in China between 2015 and 2020 (calculated using the fractional method).

306 Scopus is one of the world's largest abstract and bibliographic databases. It provides various functions and tools to track, analyze, and visualize research achievements. The collection includes more than 24,000 journal titles, 240,000 e-book titles, 78 million references, and 16 million author profiles (the above is from the Elsevier material https://www.elsevier.com/__data/assets/pdf_file/0019/1027054/20200616_Scopus-Webinar-1.pdf)

307 By Simon Baker for Times Higher Education, "China on the Rise," July 19, 2018 https://www.insidehighered.com/news/2018/07/19/china-may-overtake-us-research-impact-scholars-analysis-finds, (accessed June 12, 2021)

308 "Superpowered science: charting China's research rise," NATURE INDEX, 26 May 2021, https://www.nature.com/articles/d41586-021-01403-2?utm_source= feedburner&utm_medium=feed&utm_campaign=Feed%3A+nature%2Frss%2Fcurrent+%28Nature+-+Issue%29 (accessed June 27, 2020)

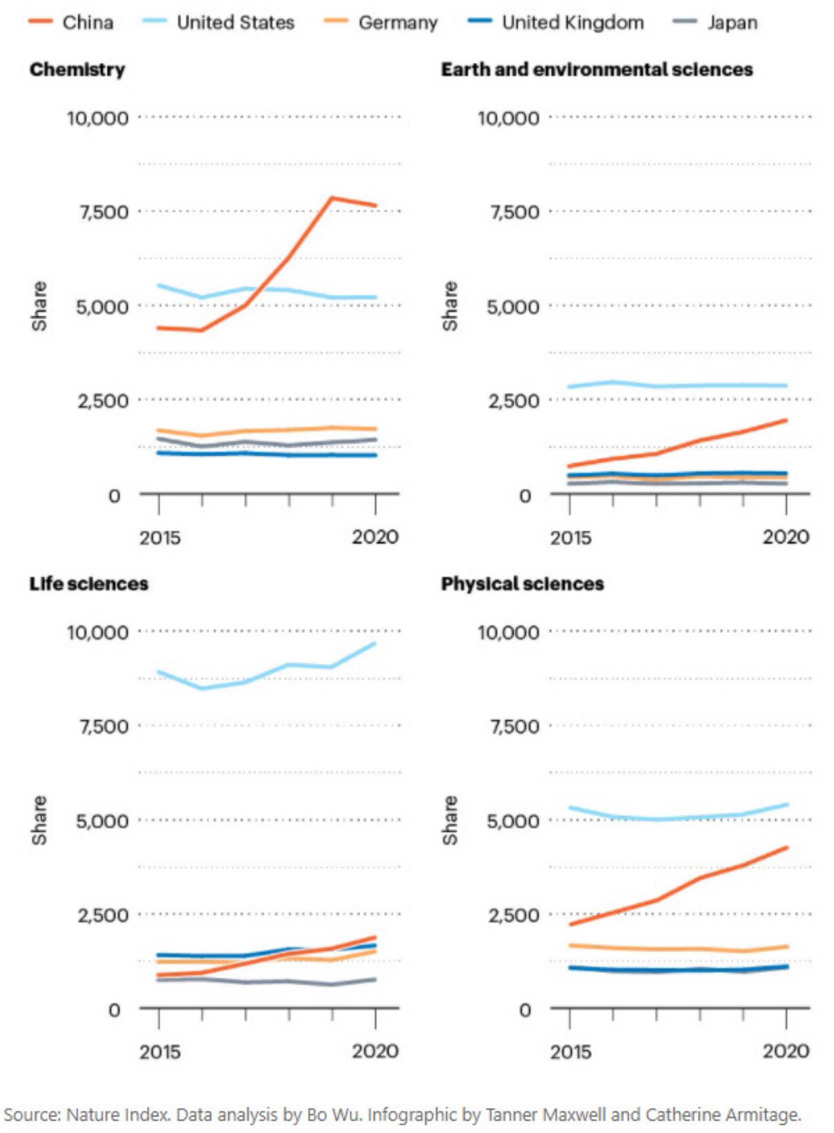


Figure 19: Comparison of the number of papers by field (from Nature Index, May 26, 2021)

4.5.7 Possibility of ascertaining the number and quality of papers by Chinese researchers

When evaluating China's strength in science and technology, the number of "Chinese" papers and their citations are used as indicators. However, it is not always clear whether papers produced with the contribution of Chinese researchers (researchers with Chinese names) are counted as Chinese results. Let us take a look at the situation with reference to a 2018 article from *VoxChina* magazine[309]. For example, when considering scientific contributions based on the location of the researcher (as determined by the name of the research institution they belong to, etc.), papers

309 Qingnan Xie, Richard B. Freeman, "China's Overwhelming Contribution to Scientific Publications," VoxChina, Sep 19, 2018, http://voxchina.org/show-3-99.html (accessed June 12, 2021)

written by researchers with Chinese names who are located outside of China are not necessarily credited as Chinese. If contributions by researchers with Chinese names who are located outside of China were counted as Chinese contributions, the number of Chinese contributions would naturally increase to some extent. One example from the above article estimates that in 2016, if the contributions of Chinese researchers located outside of China were taken into account, the percentage of Chinese papers would increase from 18.0% to 23.3%.

In addition to the degree of contribution of Chinese-named researchers located outside of China, other questions that naturally arise are whether papers are in English or in Chinese and whether journals are published in China. Perhaps owing to the peculiarities of bibliographic databases, these aspects are not always made clear. The above article also gives consideration to this point. For example, although Scopus claims that its bibliometry includes "some Chinese journals," more than 80% of its journals are written in English. According to CNKI, these papers represent only 8% (about 340 journals) of the 4,216 STEM-related journals published in China (see the footnote below, which indicates that there are about 10,000 journals included in CNKI). Scopus selects leading journals, but it clearly excludes some useful and interesting papers. The table below gives an overall picture of the Chinese-language and English-language journals and their presence in Scopus, as far as can be ascertained. The number of Chinese journals published in Chinese and English is still not fully clear.

Table 6: Chinese STEM journals and journals included in Scopus

	Total	In English	In Chinese
Chinese STEM journals	4216 (100%)	-	-
Of which journals included in Scopus	337 (8%)	270	67

(Source: Prepared by the authors based on related materials)

As shown in Figure 20, in fact, the increase in the number of science and engineering papers in CNKI is similar to the increase in the number of papers in Scopus.

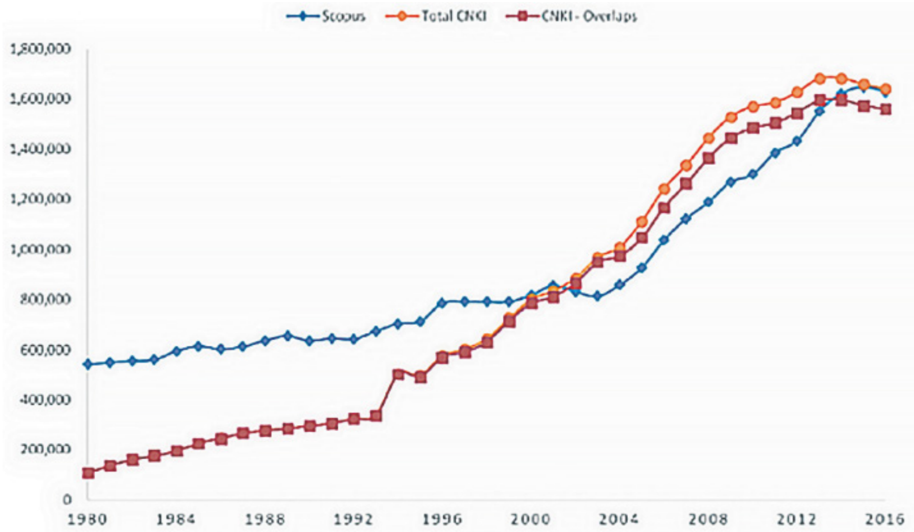


Figure 20: Number of science and engineering papers in Scopus and CNKI between 1980 and 2016

Status of papers by Chinese researchers with Chinese names located in China (from CNKI)

In terms of how papers written by Chinese authors in Chinese journals are calculated an evaluated, without going into the details, the above article states that CNKI papers may be considered to have a weight of 0.2 compared to Scopus papers, for a contribution of around 36%. In other words, even if Chinese journals published in Chinese are not included in the calculation of Scopus and other bibliographic databases, China's contribution should be estimated by adding about one third.

The article compares the quality, that is, the number of citations of Scopus papers by researchers with Chinese names located in China with those by researchers with Chinese names located outside of China. According to the article, in 2000, citations of papers by researchers in China were only 29% of the global average, whereas citations of papers by researchers with Chinese names located outside of China were more than the global average during the same period. This means that the best researchers at that time based their research outside of China. In contrast, by 2013, the number of citations of papers by researchers located in China had increased to 70% of the global average, and the number of citations of papers from research considered to be based outside of China was getting closer to the average. Incidentally, China's share of total citations increased from 7.4% in 2000 to 19.5% in 2013. This may be owing to the fact that the percentage of citations of researchers with Chinese names located in China increased as well. Finally, the article examines trends in *Nature* and *Science* papers by researchers with Chinese names located in China, from 7%-8% Chinese names and 0.5% located in China in 2000 to 20% Chinese names and 8%-9% located in China in 2016.

4.5.8 Methods to evaluate the level of science and technology in a country based on the number and quality of papers

We have presented the general widely known information about the number and quality of Chinese papers. Indeed, the number of Chinese papers is increasing, and moreover, the number of high-quality (i.e., highly cited) papers is on the rise. As mentioned above, the FWCI is barely above the world average (although Japan is also below 1.0). The number of researchers in China is said to be 1.8 million. It is reportedly difficult to calculate the number of citations of purely internationally recognized papers after subtracting citations among Chinese researchers, that is, to eliminate the influence of the number of researchers in the countries being compared. It might be possible to take into account the differences in the number of researchers in each country and average them out to compare the number of citations while offsetting the differences in the number of researchers. In Elsevier's opinion, "In our experience, we understand that it is difficult to make rigorous comparisons, even when making international comparisons, although it is sometimes tempting to consider language and cultural areas in addition to the number of researchers in a country." Given these circumstances, it is necessary to consider a bibliometric method to estimate the level of science and technology in China, including the strength of basic research, in a way that reflects the actual situation even more than current methods. One possible approach is to look at researchers who have Chinese names but do not reside in China and evaluate the papers which are the result of their research.

According to *VoxChina*[310], the number of Chinese papers, which has been increasing for the past 20 years, is somewhat underestimated, as papers by Chinese nationals without Chinese addresses are counted as non-Chinese papers. In 2016, 17% of papers with addresses outside China had at least one Chinese author and should, therefore, be counted as Chinese papers. Some argue that only researchers whose first name is also Chinese should be counted as Chinese researchers with non-Chinese addresses. Counting papers by Chinese researchers with non-Chinese addresses as Chinese (address-and-name metric) should increase the percentage of Chinese papers. For example, in 2016, the share of papers by Chinese authors out of all papers was only 18% when estimated by address but was 23.3% when using the address-and-names metric.

Another issue raised is that the Chinese journals included in Scopus, over 80% of whose journals are in English, represent no more than 8% of the 4,216 STEM journals reported by CNKI as being published in China. Perhaps, Scopus selects the best Chinese journals. However, there are quite a few interesting and useful journals that are not included in its database. According to CNKI, the total number of papers produced in 2016 was approximately 1.6 million, covering almost the total number of papers in China and roughly equivalent to that of Scopus. Assuming that the former are Chinese-language papers and that their contributions are comparable to those of non-English-language papers in Scopus, one could argue that the contributions from Chinese-language papers that do not appear in Scopus may also be quite significant. Conversely, 44.6% of CNKI papers have no citations, compared to only 29.0% of Scopus papers (both in 2013). This may be why researchers at Chinese universities are encouraged to submit English-language papers about their outstanding achievements.

VoxChina is still concerned with assessing the contribution of Chinese-language papers and is pursuing comparability between CNKI and Scopus papers. In other words, they are exploring a mutual "exchange rate." The method used by *VoxChina* is to compare the average number of citations per paper over a three-year period for both databases. According to this comparison, the average number of citations of Scopus papers in 2013 was 9.2 and that of CNKI was 2.3. On this basis, CNKI papers are considered to have an exchange rate of 0.25 with Scopus papers. However, this is only an evaluation of the number of citations within a database, and an evaluation of citations between databases is needed. When a certain number of papers was taken from each one, and the papers were compared, it was found that CNKI papers cited Scopus papers much more often than the reverse. In 2013, half of CNKI papers cited Scopus papers, whereas only 0.29% of Scopus papers cited CNKI papers (written in Chinese). Taking this into

[310] Qingnan Xie, Richard B. Freeman, "China's Overwhelming Contribution to Scientific Publications," VoxChina2, Sep 19, 2018, (Qingnan Xie, Nanjing University of Science &Technology & Labor and Worklife Program, Harvard Law School; Richard B. Freeman, Harvard & the NBER.), http://www.voxchina.org/show-3-99.html (accessed August 6, 2021)

account, the "exchange rate" between CNKI and Scopus papers would be 0.2, making the contribution of CNKI papers much lower.

The journal's analysis goes further to evaluate the quality of Chinese papers within Scopus. In 2000, papers with all-Chinese addresses received just 29% of the global average of citations, whereas papers resulting from international collaborations, with Chinese names and non-Chinese addresses, received more citations than the global average. In other words, Chinese researchers conducted their best research outside of China. By 2013, citations of papers with Chinese addresses had increased to 70% of the global average, and research conducted outside of China or through international collaboration was closer to the average. China's share of international citations also increased from 7.4% (2000) to 19.5% (2013). This was owing to the increase in the percentage of citations of papers with all-Chinese addresses.

Finally, *VoxChina* attempts to evaluate China's contribution to science by surveying papers in *Nature* and *Science* with Chinese names and addresses. It found that the number of papers with Chinese names and Chinese addresses within these journals increased from 7%-8% Chinese names and 0.5% Chinese addresses in 2000 to 7.4% and about 20%, respectively, in 2016.

4.5.9 International collaboration and papers

We have presented a variety of data about the quantity and quality of papers produced by China or by Chinese researchers. However, there are diverse ways to evaluate the quality of papers by researchers in a country, and it is difficult to make a blanket judgment. We will now introduce an interesting report compiled by the U.S. Center for Security and Emerging Technology (CSET) that evaluates the results of papers from international collaboration[311].

This report aims to clarify the relationship between international collaboration and related research results by analyzing trends in high-impact papers, especially focusing on the coauthorship relationship between the U.S. and China, which is particularly interesting in the context of the increasing importance of international collaboration to solve difficult problems. The report covers trends in internationally coauthored papers from 11 countries including China[312] between 2010 and 2019. In particular, it compares the impact of internationally coauthored and non-internationally coauthored papers in certain countries and evaluates the impact of internationally coauthored papers in China and other countries. In the case of China, the evaluation is based on a comparison of Scopus-only data and data including CNKI (called CSET Merged Corpus). Here, we will present a summary of the conclusions and refer the reader to the report for the methodology of the analysis.

Thus far, attempts have been made to present evaluations of the quality and impact of Chinese papers based on various information but that did not always result in an accurate understanding. However, the CSET report clearly draws the following conclusions.

- When CNKI is included, the percentage of internationally coauthored papers is 7% of the total, which

311 Autumn Toney, Melissa Flagg, "Research Impact, Research Output, and the Role of International Collaboration", CSET Data Brief, November 2021, Center for Security and Emerging Technology, file:///C:/Users/takayuki.shirao.kf/Desktop/%E3%82%A2%E3%82%B8%E3%82%A2%E5%A4%AA%E5%B9%B3%E6%B4%8B%E3%82%BB%E3%83%B3%E3%82%BF%E3%83%BC/%E4%B8%AD%E5%9B%BD/%E7%89%B9%E5%AE%9A%E8%AA%B2%E9%A1%8C/%E3%82%B8%E3%83%A3%E3%83%BC%E3%83%8A%E3%83%AB/CSET-Research-Impact-Research-Output-and-the-Role-of-International-Collaboration.pdf (accessed January 3, 2022)

312 China, 27 EU countries, the U.S., the United Kingdom, Japan, India, Canada, Australia, South Korea, Brazil, and Russia.

is considerably lower than the 19% in Scopus. This is because many papers are coauthored by Chinese researchers throughout China.

- The countries with the highest percentage of international collaboration are the United Kingdom, Australia, and Canada.

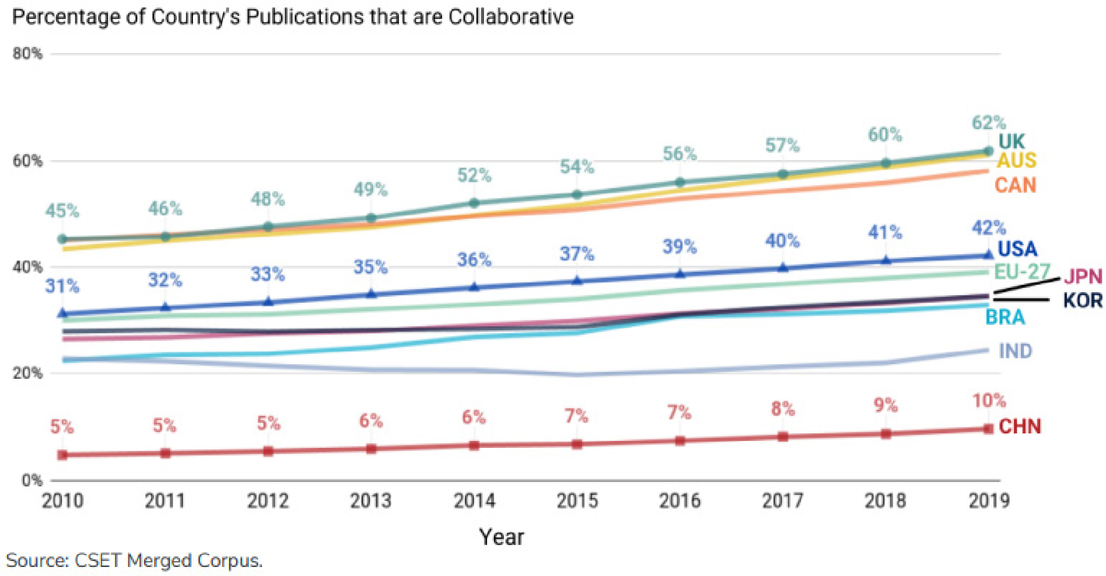


Figure 21: Trends in percentage of papers from international collaborations

Source: Excerpts from the Center for Security and Emerging Technology [CSET] report

When comparing the percentage of high-impact papers among papers that are internationally coauthored versus those that are not internationally coauthored, a smaller difference between the former and the latter is considered to indicate a higher quality of research in the country concerned. In the United Kingdom, for example, the former is 39% and the latter is 27%, whereas in China, the former is 32% and the latter is only 12%. This means that the impact of a paper is not high when only domestic researchers are involved.

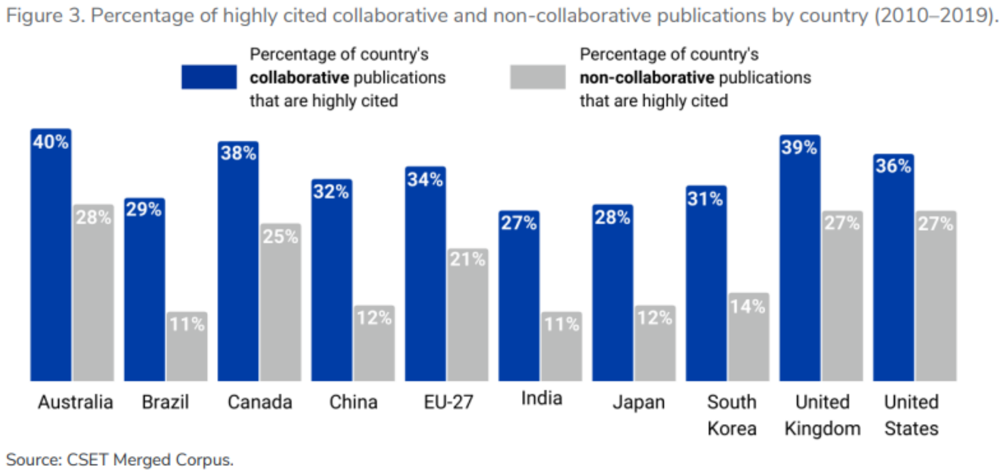


Figure 22: Percentage of highly cited international collaborative papers between 2010 and 2019 (%)

(Same as above)

① In general, the impact of a paper increases as the number of coauthors increases, and this trend is the same across the countries surveyed.

② The influence of the presence or absence of the above coauthorship relationship on the impact of papers varies by research field. For example, in China, the percentage of high-impact papers among coauthored and non-coauthored papers is 33% and 8%, respectively, in computer science; 30% and 10%, respectively, in materials science; and 33% and 5%, respectively, in medicine. Relatively speaking, international coauthorship in medicine is highly effective. Conversely, papers in the field of medicine are strongly influenced by international coauthorship.

③ The influence of U.S.-China international collaboration on the impact of their respective papers was assessed based on the percentage reduction in the number of papers after excluding papers coauthored with the partner country. For the U.S. influence on China, the reduction increased from −2% in 2010 to −4% in 2019. For the influence of China on the U.S., the reduction increased from −5% to −10% over the same time period. This means that for the U.S. and China, the respective coauthorship percentages are increasing. Conversely, if that coauthorship were to be lost, that would have significant consequences.

④ Looking at target countries other than the U.S. and China, it is clear that collaboration between Australia and China is particularly close, with a reduction of 18,309 papers, or 15%, when excluding coauthorship with China.

⑤ In general, when a country has a coauthorship relationship with China, the influence of that country losing its coauthorship relationship with China is greater than that of China losing its coauthorship relationship with the country in question. The effect of the U.S. losing its coauthorship relationship with China, as mentioned above, would be only a 4% reduction in the number of papers.

⑥ In conclusion, the results indicate that the effect of international collaboration on the impact of papers is significant. In particular, if the coauthorship relationship between China and other major countries were to be lost, the influence on the other countries would be greater than the influence on China. However, restrictions on international collaboration with China would have a significant influence on the productivity of high-impact papers in China. Based on this conclusion, it can be said that international collaboration relationships should be analyzed to understand which partnerships to invest in or divest from depending on their outcomes and impact.

4.5.10 China's position in Research Front analysis, etc.

The Research Front analysis method was basically established in 1985. For China, the CAS Strategic Advisory Institute for Science and Technology and its Literature Information Center, in collaboration with Clarivate Analytics, annually publish the results of the analysis as China's first focus area[313]. This method has unique characteristics, and its findings differ from those published by the Ministry of Science and Technology and ISTIC. The national Research Front hot index for the last five years according to this publication is shown in the table below, which reveals China's rapid progress and its encroaching on the U.S. market. Based on the results of this analysis, China ranks first in the number of hot areas in agricultural sciences, botany and zoology, chemical and material sciences, mathematics, and information sciences, as well as economics, psychology, and other social sciences, and ranks first along with the U.S. in the ecological and environmental sciences.

A notable finding is the progress of China, whose index has nearly doubled since 2017, while the United Kingdom is relatively stable and the United States, Germany, and France are declining. Despite the power of the number of citations, further refinement of evaluation methods is expected from the perspective of basic research capabilities.

Table 7: International Research Front hot index

(1) International research frontier hot index, last five years (2017–2021)

Country	2017	2018	2019	2020	2021
U.S.	281.11	227.39	204.89	226.63	209.23
China	118.84	118.38	139.68	151.29	191.43
U.K.	96.90	78.62	80.85	79.59	85.59
Germany	90.98	75.12	67.52	75.31	64.13
France	60.08	51.20	46.30	46.19	48.66

* In 2021, Japan: 31.59

(Source: Quoted from the above "Pekin Tayori")

313 [21-059] "Focus Areas" Research Front 2021 (Part 1), Pekin Tayori, JST Beijing Office, December 20, 2021, https://spc.jst.go.jp/experiences/beijing/bj21_059.html (accessed January 2, 2022)

Table 8: International research front hot index and national contribution/national impact intensity values
(2) International research frontier heat index including degree of national contribution and degree of national influence

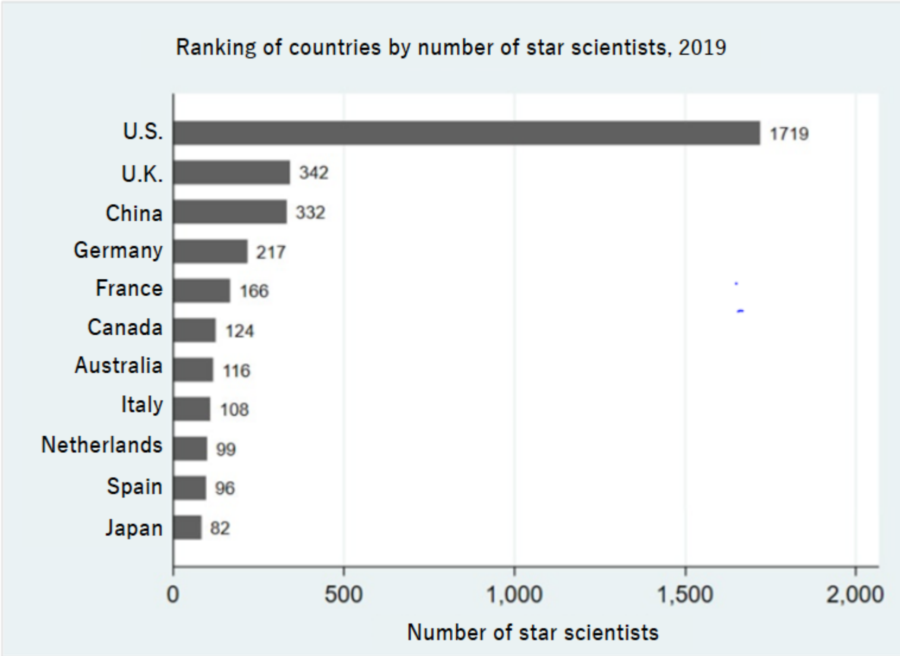
Rank	Country	International research frontier heat index	Of which degree of national contribution	Of which degree of national influence	Remarks
1st	U.S.	209.23	113.05	96.17	There is a deviation
2st	China	191.43	108.66	82.78	There is a deviation
3rd	U.K.	85.59	44.73	40.86	
4th	Germany	64.13	34.20	29.93	
5th	Italy	51.71	27.54	24.16	There is a deviation
6th	France	48.66	25.00	23.66	
7th to 10th: Australia, Canada, Spain, the Netherlands					
11th	Japan	31.59	17.75	13.85	There is a deviation

(Same as above)

The *Star Scientists White Paper 2020* is a summary of the global evaluation of researchers[314]. “The term ‘star scientists’ refers to a small number of scientists with excellent research accomplishments who publish more papers, garner more citations, and file more patents than the average researcher. They also tend to train outstanding doctoral students and postdoctoral fellows compared to regular scientists. Star scientists are more likely than regular researchers to establish ventures, and the ventures in which they are involved achieve higher performance than others. Furthermore, there seems to be a virtuous cycle between science and business, as star scientists who are involved with industry also achieve better research results.”

According to this source, China’s ranking, as shown in Figure 23, is third after Germany, which is quite high considering that Japan is in twelfth place. Although this evaluation method is also based on the number of papers and patents, it is still necessary to pay attention to how this evaluation will change in the future.

314 Maki Kanetaka, Associate Professor, Waseda Business School, Waseda University, “Finding star scientists: The collective knowledge that can be created around them will save Japan from stagnation,” POLICY DOOR, https://www.jst.go.jp/ristex/stipolicy/policy-door/ article-07.html (accessed July 3, 2022)



Although Japan is shown in 11th place in this figure, it actually ranks 12th. China lags far behind the United States. However, there are problems in the American model as well, for example, in the approach to funding.

Figure 23: Ranking of the number of star scientists

(From the material cited in the footnotes)

4.5.11 Research misconduct involving papers

As mentioned above, *Nature* and other publications have frequently reported on research misconduct in China. However, that does not mean that China has not taken measures against research misconduct. Although specific statistics are not yet available, the retraction rate of Chinese papers is unusually high relative to that of other countries. According to a November 2019 *Nature* article[315], as shown in Figure 24, China accounted for 8.2% of the total 21,859,178 scientific papers worldwide in 2017. In the same year, China accounted for 24.2% of the total 2,859 papers retracted (although the U.S. retraction rate was higher at 28.1%).

315 Li Tang, "Five ways China must cultivate research integrity," Nature, 26 November 2019 Correction 29 November 2019, https://www.nature.com/articles/d41586-019-03613-1 (accessed June 13, 2021)

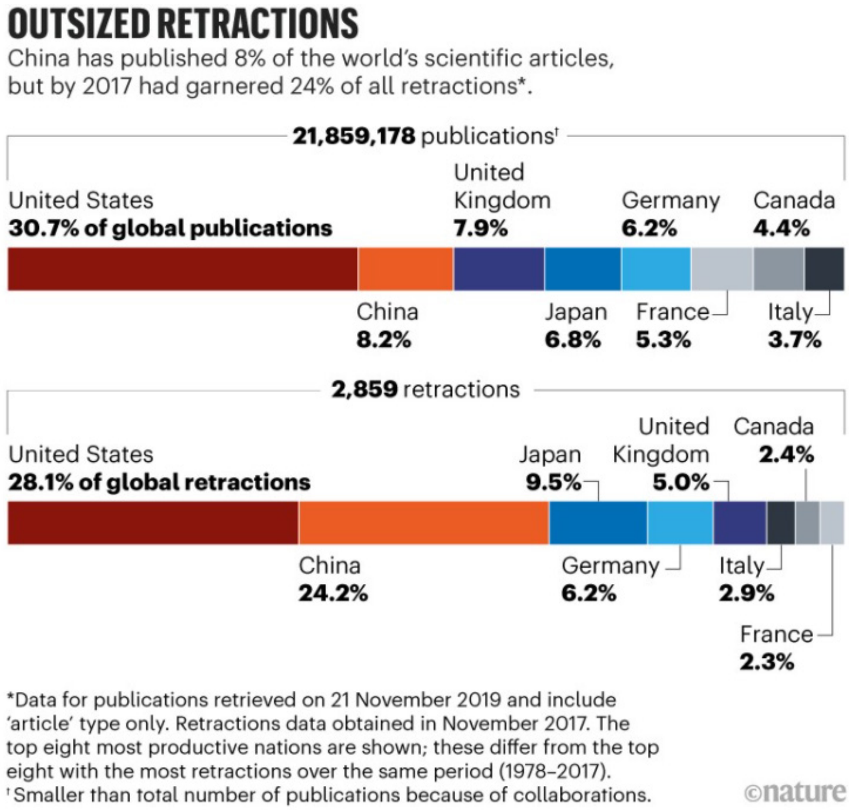


Figure 24: Percentage of total papers and retracted papers per country (%)

Source: *Nature*, November 26, 2019

According to this *Nature* article, Chinese research misconduct includes not only the commonly known FFP (fabrication, falsification, and plagiarism) but also little-known practices such as faked peer review and authorship sale. Fake peer review is the practice of falsifying or manipulating reviews in order to obtain a positive rating in a paper review or grant review. The practice of self-citing is mentioned as well. In the past, China has generally been confronted with conflicting codes of conduct, such as the need to properly respond to the demands of the times and to understand and accurately deal with international conditions, while at the same time being influenced by customary practices and leaving things to domestic circumstances. In other words, opinions have fluctuated between tacit acceptance of this practice as traditional, and the belief that it is not acceptable in the international arena and should be changed. For example, in the Chinese publishing community, it used to be acceptable to reuse other literature without proper citation, and it was not considered particularly inappropriate to submit duplicate papers in Chinese and English (this practice was abolished in 1999). In the survey from the *Nature* article, more than 20% of the researchers surveyed said that duplicate submissions and self-plagiarism[316], which are considered research misconduct internationally, are common in their field of research. This *Nature* article suggests that China needs to unify the various shifting norms in

316 Self-plagiarism is the reuse of all or part of one's own publications.

the country; establish a system of checks (Patrol) on submitted papers and research funding applications[317]; strengthen the authority to control research misconduct[318]; clarify the division of responsibility for research misconduct as well as contributions to research results; and not link publication of papers to credentials, promotion, and remuneration. Therefore, it is suggested that the Ministry of Science and Technology and the Chinese Academy of Social Sciences take the lead in institutionalizing the system and, in addition, operate the system in a transparent manner[319]. In doing so, it is recommended that a dedicated research integrity manager be appointed at each university and scientific institute, that the relevant department relate the efforts of each institution to research support, that necessary training activities be conducted at all universities and institutes[320], and that a data validity check by a principal investigator or a check of original data by multiple investigators be required. Nevertheless, another recent article in *Nature*[321] reports that paper fabrication by the abovementioned paper mills is still rampant. Fabrication of papers through the duplicate use of figures and tables is common, especially in medical and biological papers involving gene sequences, which contain complex and difficult-to-detect data such as nucleotide sequences. Journals are spending a great deal of time and effort to determine the authenticity of papers and are being forced to take measures such as exchanging information and establishing mutual defensive systems. In particular, there are "business" services that falsify papers for doctors who are too busy treating patients to write the number of papers required for promotion. The sophistication and seriousness of such paper fraud, especially from China, is increasing, and journals are said to be on high alert[322].

This suggests that it is important to fully investigate what institutions and training can permanently ensure research integrity in China, as has been done in other countries. In May 2018, the Central Office of the Communist Party of China and the Central Office of the State Council issued the "Opinions on further strengthening credit building in scientific research," (see section 2.5 (2) ③), which took strict measures against paper fraud, including so-called FFP. Subsequently, in October 2019, the "Research regulations for the investigation and handling of integrity cases (for trial implementation)[323]" were promulgated. These regulations provided additional rules on the purchase and sale of papers and applications, falsification of peer review expert comments, and so on. The aforementioned *Nature* article was published in November 2019, followed by the March 2021 *Nature* article on paper mills. However, in October

317 According to the *Nature* article in footnote 191, CNKI has implemented plagiarism-checking software for submitted papers, and the NSFC has also implemented plagiarism checks for grant applications. The article also warns that many organizations in China respond only if they are reported or sued and that warnings from such a system of checks (so-called fire alarm responses) will not regulate future behavior if they merely respond to past incidents.

318 This is also necessary to correct the tendency to respond only if sued. Incidentally, in 2017, more than half of the researchers who said they had encountered research misconduct in the past three years said they had done nothing about it.

319 In China, when a submitted paper is rejected, it is not announced as a "retracted paper" as is done in Western journals. It is also said that researchers who repeatedly submit self-plagiarized papers should be publicly blacklisted.

320 Many Chinese universities now require undergraduates to take a course called "Responsible Conduct." Three quarters of the students surveyed received training in research ethics and research integrity. Fudan University's doctoral students are required to earn ethics credits, and only those who pass can enter the program.

321 Holly Else & Richard Van Noorden, "The fight against fake-paper factories that churn out sham science," Nature, 23 March 2021, https://www.nature.com/articles/d41586-021-00733-5 (accessed September 6, 2021)

322 Another survey conducted by *Nature* found that more than 370 papers have been retracted owing to paper mills and that there are more than 1,000 papers that are questionable. When the 370 retracted papers were aggregated and analyzed, it was found that they were all from China. Most of them were published within the last three years, and *Nature* confirmed that "an additional 197 papers from authors affiliated with Chinese hospitals have been retracted since the investigation began" (Medical English Service, Science News, https://www.med-english.com/news/vol91.php accessed September 7, 2021).

323 October 2019, "Rules for the Investigation and Handling of Discreditable Conduct in Scientific Research," http://www.most.gov.cn/xxgk/xinxifenlei/fdzdgknr/fgzc/gfxwj/gfxwj2019/201910/t20191009_149114.html (accessed February 8, 2022)

2021, *Nature* continued to point out the problem[324]. Even today, negotiations for ghostwriting of papers occur on social media, indicating that the problem of research integrity in China is not necessarily moving in the direction of improvement. The issue of research integrity will be further addressed in section 7.4.

4.5.12 System of monetary rewards for papers

Finally, we must mention monetary rewards for papers. The article by Sonia Qingyang of the Max Planck Institute cited above[325] reports specifically on the matter. Furthermore, we will present a paper entitled “Publish or impoverish: An investigation of the monetary reward system of science in China” by Wei Quan et al. of the School of Information Management at Wuhan University[326]. To date, there has been no systematic study of this issue, except in specific cases, and this paper provides valuable information. In this section, we will look at the facts of the issue while reviewing the contents of the paper.

According to this paper, monetary reward systems begin as internal measures and are often kept secret. However, in China, the practice of giving monetary rewards for scientific achievements has existed since the 18th century, to the extent that prestige is symbolically expressed in monetary terms. This practice is said to have transformed into financial incentives for publishing papers (“cash-per-publication“) in the 1980s.

Academic prizes were first introduced by the French Academy of Sciences in 1719, followed by the establishment of a kind of academic prize system at the Royal Society in London. Since then, a wide variety of academic prizes with financial rewards have been created around the world, the most famous example of which is certainly the Nobel Prize. Academic prizes include many aspects, from recognition, citation, and acknowledgment of authorship to academic awards, honorary fellowships, membership on academic committees, and mentorship. Monetary rewards, however, are also given for outstanding achievements, as exemplified by the Nobel Prize. Some believe that performance for the sake of monetary reward is contrary to the fundamental principle of “disinterestedness[327].” In the United Kingdom, the Research Assessment Exercise (RAE) was introduced in 1986 to provide cash bonuses to individual researchers rather than to research institutions. Policies that provide economic incentives have, in fact, had an impact on university research, both in terms of research institutions and individuals.

Owing to space constraints, this report cannot provide a detailed description of the historical development of Chinese universities. However, there are 2,595 higher education institutions in China, 1,236 of which have so-called university programs that fall into approximately three categories. The first is “Project 211” designated universities, introduced in 1995; the second is “Project 985” designated universities, introduced by General Secretary Jiang Zemin

[324] Holly Else, “China’s clampdown on fake-paper factories picks up speed,” Nature, NEWS, 01 October 2021, https://www.nature.com/articles/d41586-021-02587-3 (accessed February 3, 2022). This article reports that two Chinese funding agencies have punished 23 scientists for using paper mills.

[325] See footnote 211.

[326] Wei Quan, School of Information Management, Wuhan University, Wuhan, China Bikun Chen, School of Economics and Management, Nanjing University of Science and Technology, Nanjing, China, Fei Shu, School of Information Studies, McGill University, Montreal, Canada, “Publish or impoverish: An investigation of the monetary reward system of science in China (1999-2016),” https://arxiv.org/ftp/arxiv/papers/1707/1707.01162.pdf (accessed July 17, 2021)

[327] “Like other institutions also, science has its system of allocating rewards for performance of roles. These rewards are largely honorific, since even today, when science is largely professionalized, the pursuit of science is culturally defined as being primarily a disinterested search for truth and only secondarily a means of earning a livelihood.” (Roberting Merton, 1957, p. 659), *ibid.* p. 6

in 1998; and the third is other universities. At the time of conducting research for this paper, there were 39 “Project 985” universities, 73 “Project 211” universities, and 1,124 other universities in China. There is a clear differentiation in financial support between these universities. Between 2002 and 2015, the amount of funds invested in “Project 211” and “Project 985” universities increased from USD 23.86 million to USD 113.05 million. The amount invested in other universities during the same time period increased from USD 1.89 million to USD 9.27 million, indicating a stark difference (due to the “Matthew effect”). Financial support for universities comes not only from the central government but also from local governments. However, financial support for universities in more developed regions (the North, Northeast, East, and South) is greater than that in other regions. The financial wealth of Project 211 and Project 985 designated universities in developed regions is evident. Furthermore, financial support for Project 211 and Project 985 universities accounts for 70% of total R&D expenditures for all universities, and 80% of the enrollment of doctoral students. After Project 211 and Project 985, a “Double First-Class” policy was introduced, which has been in place ever since. Incidentally, according to this paper, Chinese papers are mainly published by universities (73.4% of the total, China Statistics Bureau 2015). These papers account for 83% of those published on the Web of Science.

Since the 1980s, it has become common practice for Chinese universities to evaluate research results based on the number of papers on the Web of Science (WoS), thereby enhancing the international visibility of Chinese research. This has encouraged scholars and researchers to publish in WoS-indexed journals. The first to institute a policy of monetary rewards for papers was the Physics Department of Nanjing University around 1990. The reward was USD 24 per WoS paper, which later rose to USD 60 and to USD 120 in the mid-1990s. As a result, Nanjing University maintained the top spot on the list of WoS paper published in China for seven consecutive years in the 1990s. The policy and performance of Nanjing University is said to have been “imitated” by other universities and research institutions, which introduced similar research evaluation methods and monetary reward policies.

There have been many scholars and studies evaluating the positive impact of monetary rewards for papers on research activities in China (namely, increased scholar motivation and productivity of papers). However, there have been no studies comparing monetary rewards across different universities or across the country as a whole.

On the other hand, financial rewards can also have negative effects. To begin with, Chinese researchers prefer “fast research” and “quick, cashable publications” to “long-term research,” and their research goal is to publish WoS papers. This reportedly leads to cases of plagiarism, falsification, ghostwriting, and authorship sale. Project 211 and Project 985 universities have ample research funds, and the financial rewards for papers are higher than in other categories. Monetary rewards are intra-departmental awards announced in internal university documents, and some universities keep them secret to avoid competition. Although they have existed for 20 years or so, little is known about 1) the amount of monetary rewards, 2) differences by journal quality, and 3) differences among universities. Therefore, this paper aims to provide as complete a picture of these issues as possible.

Note that the fields covered in this paper are the natural sciences, including engineering and medicine, and not the humanities and social sciences, for which paper evaluation methods vary by region and university. In any case, monetary reward programs apply only to WoS papers in the natural sciences.

The methodology of the survey is as follows. The 1,236 Chinese universities were divided into 21 categories based on the three categories of universities established since the 1990s (“Project 985”, “Project 211”, and “other”) and the regions of China, and 100 universities were ultimately selected. As many internal documents related to monetary rewards as possible were obtained through Baidu for each university, and their official status and validity were confirmed through various methods.

A total of 100 universities were selected from seven regions, including 25 out of 39 Project 985 universities, 33 out of 73 Project 211 universities, and 42 out of 1,124 other universities. The selected universities operated a total of 168 monetary reward programs. Of these, 45 operated 1 program, another 45 operated 2 programs, and Nanjing University and Guizhou Normal University operated 4 to 5 programs. This survey is problematic in that it is not a random sampling. However, it is highly representative because there do not appear to be significant differences between universities, in general, and the selected universities in terms of number of science and technology personnel, number of international publications, research funding, and number of students.

Monetary reward programs differ from university to university due to various specifications in terms of eligibility criteria, reward amount, calculation method, payment method, and so on. Therefore, it is difficult to make a general comparison. Nine leading journals were selected, including *Nature*, *Science*, and *PNAS*. In each of the programs, the five-year impact factor was the primary criterion used to calculate the amount of the reward.

The results of the analysis are summarized below.

Rewards ranged from USD 30 to USD 165,000 per paper in a WoS journal, with the average reward increasing over the last decade.

In terms of eligibility, the WoS, which includes the Science Citation Index Expanded, occupies an important place in China's monetary reward programs. The WoS and the Journal Citation Report are used as indicators of eligibility and rank of the reward. In all monetary reward programs, only WoS papers qualify for monetary rewards (as an exception, some universities offer small rewards for papers indexed in Engineering Index[328]). WoS papers receive different reward amounts depending on the journal in which they are published. The monetary reward programs of the 168 universities can be divided in the following four groups.

① Universities paying one-price rewards for all WoS papers regardless of the journal in which they are published (31 universities)

② Universities paying different reward amounts based on the impact factor of the journal in which the paper is published, with higher impact factors resulting in greater rewards (49 universities) (Some universities use the impact factor as a multiplier to increase the amount of the reward)

③ Universities using the Journal Citation Report (JCR) Quartiles revised by CAS for the journal in which the paper is published to calculate the amount of the reward (99)

④ Universities using the number of citations of the relevant paper in a certain citation period to calculate the amount of the reward (15) (Some universities set a threshold for the number of citations and reward papers that exceed this threshold)

The total is more than 168 because some universities belong to more than one group. Looking at historical trends, in 1999, most universities paid one-price rewards, but by 2016, the percentage of these universities was decreasing. JCR-based rewards emerged around 2003, increased thereafter, and accounted for more than half of the total in 2016. Universities paying citation-based rewards emerged in 2008 and gradually increased thereafter.

As for authors, 118 of the 168 universities paid only the first author, and 22 of the 168 universities paid the first author when they were also the corresponding author. In exceptional cases, such as papers published in outstanding

328 "Engineering Index is an engineering bibliographic database published by Elsevier. It indexes scientific literature pertaining to engineering materials." *Ibid.* p. 9

journals (*Nature*, *Science*, etc.) rewards were paid to non-first authors for the same amount or a reduced amount (e.g., half the amount for the second author).

The average amount of the rewards was calculated by analyzing 75 cases in 40 universities with active reward programs between 2008 and 2016. According to the analysis, the average amount paid has gradually increased. The amount paid for each journal is summarized below.

① *Nature*, *Science*: The most prestigious journals. Authors who published in these journals received special treatment and were paid the highest rewards. Authors received rewards up to USD 165,000, and in some universities, the amount was negotiable. The average reward increased from USD 26,212 (2008) to USD 43,783 (2016).

② *PNAS*: Similarly prestigious, although not to the level of special treatment. Authors were paid more than USD 3,000 per paper, and the average reward increased from USD 3,156 in 2008 to USD 3,513 in 2016.

③ *PLOS ONE*: Recognized as a Q1 journal. Authors were paid around USD 1,000 per paper. However, the average reward decreased from USD 1,096 in 2008 to USD 984 in 2016.

Publication in *Liberty Hi Tech* and *LIBRI* resulted in the smallest rewards among the nine journals selected, and the average reward showed a decreasing trend, from USD 650 in 2008 to USD 484 in 2016.

Meanwhile, the results of another survey show the following rewards[329].

Table 9: Trends in amount of monetary rewards per paper published in relation to the types of papers published

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Nature, Science	$26,212	$26,006	$25,781	$25,365	$33,990	$36,658	$38,908	$43,783	$43,783
PNAS	$3,156	$3,025	$3,353	$3,443	$3,664	$3,619	$3,751	$3,513	$3,513
PLOS One	$1,096	$1,086	$1,035	$994	$991	$915	$941	$984	$984
MIS Quarterly	$2,613	$2,570	$2,553	$2,654	$2,876	$2,861	$2,992	$2,938	$2,938
JASIST	$1,737	$1,758	$1,741	$1,887	$2,066	$2,303	$2,435	$2,488	$2,488
Journal of Documentation	$1,082	$1,087	$1,042	$1,111	$1,167	$1,265	$1,329	$1,408	$1,408
Library Hi Tech	$781	$775	$726	$741	$740	$768	$795	$783	$783
LIBRI	$650	$644	$577	$560	$538	$509	$517	$484	$484

* All the amounts are full amount (in USD) awarded to the first author

The average amount of paid by Chinese universities for a paper published in selected journals between 2008 and 2016

(Source: As per the footnotes in the text)

One interesting difference between Project 211 and Project 985 universities and other universities is that other universities received higher rewards for all journals (for example, the average reward for publication in *Nature* was USD 38,846 for Project 985 universities, USD 53,823 for Project 211 universities, and USD 63,187 for other

329 Tech Policy: "The Truth about China's Cash-for-Publication Policy, The first study of payments to Chinese scientists for publishing in high-impact journals has serious implications for the future of research", By Emerging Technology from the arXivarchive page, MIT Technology Review, July 12, 2017, https://www.technologyreview.com/2017/07/12/150506/the-truth-about-chinas-cash-for-publication-policy/ (accessed February 9, 2022)

universities). This may be because other universities conduct more rigorous evaluations and target higher-quality papers. Other universities are also believed to operate such reward systems to attract more talented researchers.

In contrast, there were no differences in reward amounts by region.

This concludes the overview of publication reward programs in the Chinese universities surveyed in this paper. Some of the arguments developed in the paper are presented below.

Monetary reward programs were originally used by businesses as an incentive for employees. However, given the low salaries of university professors, not to mention young researchers, the rewards paid for papers are quite high. Naturally, this will improve the future research funding and research environment for these researchers. China has successfully introduced this system into the research world and has been using it for the past 20 years.

However, the monetary reward programs described in this paper have had negative effects. These programs encourage researchers to conduct short-term studies that are likely to yield results and are a leading cause of research misconduct, including plagiarism, falsification, ghostwriting, and faked peer review. The most blatant example is that of Gao, a researcher who wrote 279 papers in the same journal on the same crystal structure and was paid more than half of Heilongjiang University's rewards (according to WoS searches, the number of requests for author corrections increased from two in 1996 to 1,234 in 2016.) The adverse effects of excessive use of bibliometric indicators in performance evaluation are also noted. Specifically, with a few exceptions, reward programs mostly use the WoS database, with no regard for other databases such as Scopus, or even for results published in Chinese journals, which contain millions of papers.

Of course, positive effects are seen as well. The transition from one-price reward programs to JCR Quartile-based reward programs since 2008 can be considered a shift in the direction of valuing papers' quality over quantity.

In March 2020, Nature reported that a document issued in February of that year instructed universities to stop paying rewards for papers, based on guidelines from Chinese authorities regarding evaluation systems[330]. As mentioned above, the number of papers published in China has increased dramatically over the past 20 years. During that time, the method of evaluating researchers and research institutions based on the SCI evaluation of journals and using the increase in the number of papers as a benchmark has become established in higher education institutions and scientific research institutions. On the other hand, it has been noted that there are many cases of research misconduct, such as fake peer review and the use of fraudulent research data, as described above. Against this backdrop, Chinese authorities have endeavored to emphasize the quality of papers, taking the strong view that using the number of SCI papers as a criterion for reward, performance evaluation, and even funding has the effect of encouraging research misconduct. Although some welcome this measure, others are concerned that it may only lead to a decrease in the number of papers and hinder the competitive environment for Chinese researchers. Furthermore, some believe that the emphasis on Chinese-language papers could make Chinese researchers invisible to the rest of the world. In a sense, these guidelines call for more emphasis on peer review among researchers. However, there are also concerns that peer review may be too subjective and too dependent on personal relationships. Some experts believe that unless a culture of peer review truly takes root, this is where new problems may arise. It will be very interesting to see what research trends will emerge because of the application of these new evaluation standards.

330 Smriti Mallapaty, *Ibid.* For measures prohibiting compensation for papers, see section 4.2.2.

5 Funding Mechanisms in China: Realities and Current Status of Reform

Different countries' science and technology institutions exhibit different characteristics depending on each country's culture and traditions, political and economic system, and emphasis on science. Funding institutions are an important part of the system that supports academia. Their establishment and development can be indicative of the basis of the system and its environmental conditions. To understand China's funding institutions, one must first grasp the trends in China's scientific and technological development and the process by which it has been systematized. The funding institutions discussed in this section refer to the system of funds disbursed as external funds, including so-called competitive funding, as well as funds disbursed to research institutions as institutional subsidies.

5.1 Changes in Chinese funding institutions

From a historical perspective, China has long been a self-sufficient feudal society[331] with very little need for science and technology. Academic research was focused on Confucian ideology and the imperial examination system. Science and technology were considered outside the scope of academic research, and there was very little awareness of natural sciences and academic freedom. The image of science and technology at that time was that of manual labor (simply put, something similar to manufacturing). It was an unpopular field because it was perceived as work performed by the lower classes. In China, where science itself was not institutionalized, there was obviously no avenue to discuss funding institutions.

5.1.1 Foundations of funding institutions

In European countries, science had been institutionalized since the 17th century, and funding institutions had been developed in parallel. In the case of China, however, it was only in the late 19th century that the country finally got its start in scientific development. At the time, the bureaucrats of the Self-Strengthening Movement[332], led by Li Hongzhang, proposed the principle of "Chinese learning as substance, Western learning for application." This meant that the country should utilize Western technological civilization to acquire wealth and military power. Nevertheless, most scientific research[333] activities during this period were conducted independently by individuals, were decentralized, and did not attract much attention. The fall of the Qing Dynasty brought an end to the long

331 Feudal society is a form of society whose economy is based on the exploitation of the peasants by the landlord class. In the case of China, feudal society in the narrow sense of the term extends from the beginning of the Qin dynasty (221 BCE) to the end of the Qing dynasty (1911) and, in a broad sense, to the establishment of the People's Republic of China (1949).

332 A political faction that existed from the 1860s to the 1890s. It grew significantly after the Second Opium War, especially through the Taiping Rebellion. Their slogan was "self-strengthening and wealth building" (in Chinese: 自強、求富).

333 In Chinese government documents, the term "scientific research" is used more frequently than the terms "science and technology" or "research and development" when referring to plans, institutions, or personnel.

feudal society, and the Republic of China was established in 1912. From this point on, scientific education began to be emphasized, and an increasing number of people began to study abroad. In 1914, nine people including Hu Mingfu, who had studied at Cornell University in the U.S., founded the "Science Society of China" in the United States. Four years later, the society moved its base to China. This marked the beginning of the institutionalization of science in China. Subsequently, the "Academia Sinica" was established with government support in 1928. Although academic development was expected, the development process was hindered by incessant war, which made the implementation of a nationwide science and technology plan practically impossible. The government of the Republic of China (below, "the republic") did its best to support the National University and Academia Sinica.

Now, we will briefly discuss the China Foundation for the Promotion of Education and Culture (below, "China Foundation"). The China Foundation is a foundation established by the Republic of China in 1924 for the purpose of promoting educational and cultural programs. It was run using part of the compensation under the Boxer Protocol, which was refunded to China by the United States and other countries[334]. The foundation invested a large sum of money, in excess of USD 12,545,000, solely on education, scientific research, and human resource development in China. The funds were managed directly by a board of trustees, rather than through the government, and enabled outstanding individuals such as Chao Yuen Ren, Qian Xuesen, Chu Coching, and Tsung-Dao Lee to study abroad, greatly contributing to the future development of scientific research projects. Although the China Foundation was established by chance with the help of other countries and is quite different from today's funding institutions, it is a valuable entity that provided material security for the development of academics and the cultivation of human resources during China's republican era.

5.1.2 Government financial support before the Chinese economic reform

From the republican era, the perception of science began to change, and government funding for academia gradually increased. According to a list of academic societies published by the Ministry of Education of the Beiyang government[335], there were a total of 44 societies established between the first year and the fourteenth year of the republican era (1912 to 1925), half of which were in the natural and applied sciences. The abovementioned establishment of the Academia Sinica can be seen as the beginning of the government-led development of scientific research projects. From this point on, the professionalization of academic research also began in earnest, marking the end of an era in which there had been no scientific research institutions. The majority of funding for the Academia Sinica came from the republican government, which inevitably led to government involvement and control. As a result, the government and the Academia Sinica were often in conflict. In the 1940 election of its president, the Academia Sinica opposed government involvement and insisted on an independent election. This delayed the election of the

334 There are various theories as to why this reimbursement was made, including (1) China became one of the victorious nations after World War II and was paid compensation from other countries, mainly the United States, for the unequal treaties and (2) the treaties at the time did not state whether compensation was to be converted into silver or gold, and as China and the U.S. were negotiating over this issue, the U.S. let it slip that they had asked for more compensation than they had actually lost. The exact amount of the compensation was recalculated, resulting in a reimbursement.

335 The term Beiyang, literally "North Sea," refers to the Bohai Sea, the Yellow Sea, and the area around the Korean Peninsula. The Beiyang government, which ruled from 1912 to 1928, was a central government led by the centrals of the Beiyang Army. It was the first Chinese government to be internationally recognized since the end of the Qing dynasty, as well as the first to achieve a peaceful regime change.

president for six months longer than planned. Although many were concerned about the coexistence of State power and academic freedom, the Academia Sinica was recognized as a free academic organization that upheld academic independence and self-respect.

In 1949, when the People's Republic of China was established, China reformed its academic system on the model of the then Soviet Union. The reforms were intended to "meet the demands of national construction and support the academic activities of citizens and peasants." China adopted the scientific research slogan "advance science and realize national revival." In what can be seen as a continuation of the Academia Sinica's organizational structure, one month after the founding of the People's Republic of China, CAS was created as the nation's highest academic institution and national scientific research center. Adopting the former Soviet Union's model of separation of science and teaching, universities were in charge of scientific education, whereas CAS and other national research institutions had basic research as their primary mission. Therefore, government support for scientific research during this period consisted of support for CAS. At the time of the founding of the country, the number of science and technology personnel nationwide was less than 50,000, and the realities of science and technology in the modern sense were not yet understood. To attract the best and the brightest, the government formulated science and technology plans and developed scientific research activities by operating CAS at full government expense. This was when China's distinctive "government-led academic system" began to take hold.

In 1956, the Science and Technology Commission headed by Premier Zhou Enlai was established, and CAS departments and more than 600 scientists from across the country pooled their wisdom to formulate the "Outline of the Long-term Plan for the Development of Science and Technology for 1956-1967" (commonly known as the "Twelve-Year Plan"). The implementation of the Twelve-Year Plan was very well organized, and important projects were developed under the direct guidance of the Party's local leadership. In 1962, a central expert committee consisting of Zhou Enlai and 14 government leaders was established to conduct nuclear research and produce great scientific and technological achievements, such as the "Two Bombs, One Satellite" program.

At the time of the country's founding, its scientific and technological development was far behind that of other countries. Therefore, government support for scientific research institutions was indispensable. This active support by the government arguably led to significant development in scientific projects. In contrast, under the planned economy system, there is a strong sense of centralization, and opinions are certainly divided as to whether this mechanism is capable of guaranteeing academic freedom. However, this system is most likely a consequence of the initial political and economic situation in China.

5.1.3 Establishment of funding institutions

We will now discuss funding institutions, and to aid in understanding, we will first give an overview of the Chinese terminology.

① The type (category) of national-level funding projects refers to the official notation on the relevant websites (see Table 10).

② The activities developed under each category are called "**programs.**" For example, the NSFC has a General Program, a Key Program, and a Major Research Project Program.

③ Individual "**projects**" are developed under the umbrella of each program; for example, the NSFC's Major Program includes the Physical Mechanics Theory and Methods Project and the Cell and Tissue Mechanics and

Biology Issues Research Project.

④ Under the umbrella of each program, in addition to projects, there are "**tasks**" that are smaller in scale and shorter in duration of implementation than projects.

Therefore, applicants can apply for either projects or tasks.

Table 10: National-level funding projects

	Type	Official name	Introduction	Competent department	Remarks
1	National Natural Science Foundation of China	国家自然科学基金	Support focuses on basic research and applied basic research. There are many programs to support young researchers and original, innovative research.	Ministry of Science and Technology	In this report, the term Natural Science Foundation of China (NSFC) will be used.
2	National Science and Technology Major Projects	国家科技重大专项	Aim to complete major strategic products and major processes of key general-purpose technologies within a certain period of time (emphasis ours) through breakthroughs in core technologies and concentration of resources to realize national goals.	State Council	Often linked to five-year plans.
3	National Key R&D Program of China	国家重点研发计划	Aims to overcome technological bottlenecks in major areas of national economic and social development, including research of significant social benefit in the civilian sector and critical science and technology issues related to industrial innovation competitiveness, independent innovation capabilities, and national security.	Ministry of Science and Technology	This has been integrated with the existing National Key Basic Research and Development Program (commonly known as the 973 Program) and National High-tech R&D Program (commonly known as the 863 Program).
4	Science and Technology Innovation Guidance Program	科技创新引导计划	Established to encourage innovation and support corporate innovation and entrepreneurship by human resources, especially university students and young researchers.	-	Regions proceed in accordance with the general guidelines, with consideration for local characteristics.
5	Base and Talent Program	基础和人才专项	Aims to improve local innovation capabilities by utilizing local resources, building science and technology innovation bases, and fostering excellent research personnel.	-	Regions proceed in accordance with the general guidelines, with consideration for local characteristics.

(Prepared by the authors based on various sources)

After the Cultural Revolution, economic reforms began to take place, and scientific institutions and scientific research management methods began to change. At the National Science Congress in 1978, Deng Xiaoping stated that "science and technology are part of the productive forces." This led to the creation of funding institutions led by the scientific community rather than the government. When considering science funds, many people may first think of the NSFC. However, China's first science fund was the Science Fund of the Chinese Academy of Sciences, rather than the NSFC. In May 1981, during the Fourth Congress of Academicians held at CAS, 89 CAS members issued letters to the CPC Central Committee requesting the establishment of a Science Fund of the Chinese Academy of Sciences. In November of the same year, the Science Fund Committee of the Chinese Academy of Sciences was created to address scientific research based on the free initiative of scientists and a peer evaluation system.

In 1985, the central government enacted the "Decision on the reform of science and technology systems," which stated, “Science funding institutions will be implemented for basic and partially applied research. Funds will be provided from the national budget, and the National Natural Science Foundation of China and other science and technology funds will be established.” As preparations for the establishment of the NSFC were underway, scientist Tsung-Dao Lee visited CAS and met with Deng Xiaoping. He suggested that a separate independent Natural Science Foundation should be established for scientists to take the lead in basic and applied research. Deng Xiaoping agreed to try this approach, and the NSFC, which is not controlled by CAS, was established the following year[336].

The establishment of the NSFC was an important event signifying that basic and applied research in China was on the right path in terms of funding institutions. The National Science Foundation and departments under the State Council called for the establishment of science funds for provincial and municipal government agencies and bureaus[337] across the country. This led to the creation funding institutions in the form of coexisting funds by provincial and municipal-level agencies and bureaus centered on the NSFC.

Table 11: Classification of funding at each administrative level

National level	Provincial level	Municipal level (excluding prefectural cities)[338]
NSFC and other programs Examples: programs supervised by the State Council or the Ministry of Science and Technology (e.g., the National Key R&D Program of China, as shown in Table 10).	Programs supervised by each ministry’s Education Agency and Science and Technology Agency Examples: Guangdong Provincial Natural Science Foundation Program, Guangdong Provincial Science and Technology Breakthrough Program (Original term: 科技攻关项目), and so on.	Programs supervised by the Science and Technology Bureau, Education Bureau, etc., of each city Examples include the Major Science and Technology Innovation Platform Program of the Chengdu Science and Technology Bureau, Sichuan Province.

(Source: Prepared by the authors based on various sources)

As readers may have gathered from the previous explanations, funding institutions for China’s scientific research projects were established to meet national development and academic demands, and the government took the lead in managing the funds and enacting related policies. Therefore, government-led management was the main focus, and scientific management, such as peer evaluation, was considered an extra.

At the time, scientists actively sought to conduct peer evaluations in the adoption of projects. While taking into

336 The NSFC was established by the 1986 “Notice on the Establishment of the National Natural Science Foundation of China.”

337 National-level government organizations are referred to as “ministries” such as the Ministry of Education and the Ministry of Science and Technology. Provincial-level organizations are referred to as “agencies” such as the Science and Technology Agency and the Education Agency. Municipal-level organizations are referred to as “bureaus” such as the Science and Technology Bureau and the Education Bureau. Thus, “agency” and “bureau” are terms used to refer to the various departments under the local governments.

338 Let us briefly describe the administrative divisions of China. China’s administrative regions are divided into provincial, municipal, prefectural, county, and township levels. The provincial level includes provinces such as Shandong and Sichuan, direct-administered municipalities such as Beijing and Shanghai, and autonomous regions such as the Xinjiang Uygur Autonomous Region, which are home to ethnic minorities. The municipal level includes prefectural cities and autonomous prefectures, which are home to ethnic minorities. Unless otherwise explained, a city refers to a municipal city.

consideration the interests of the nation as a whole, there was also a desire to strengthen China's role as part of the scientific community. The government accepted the proposal and decided to conduct peer evaluations, presumably because it considered these to be a necessity in the context of national development and because conducting these evaluations would not pose a threat to government leadership. With the cooperation of politicians and academics, funding institutions have expanded from simply supporting scientific research institutions to supporting projects, and implementation methods have progressively improved, as described in the following sections.

Although the government takes the lead in establishing various policies and measures for funding institutions in general, internally, the funds are managed independently by the scientific community. In the case of the NSFC, more than 15 different programs have been implemented, including general programs, key programs, and major programs, and their scope is still expanding. Programs have been progressively subdivided and expanded to support not only research projects but also human resources, platforms, and international collaborations. The management of funds also incorporates a variety of methods, including expert consultation, performance evaluation, professional oversight, and research misconduct management. As a platform, the NSFC operates the Science Fund Management System, which not only publicizes various policies and information but also includes an application and evaluation system for projects.

5.2 Characteristics and current status of funding institutions in China

Funding institutions in China are based on centralized management by the central government. Under the leadership of the Ministry of Science and Technology, medium- and long-term science development programs are formulated based on the demands of national scientific and technological development and then published as central government policies. In response to these policies, local governments (provinces, cities, autonomous regions, etc.) and their respective bureaus and agencies adjust and implement the policies according to the circumstances of the regions, agencies, and bureaus in question. For example, after the State Council released its "Opinions on improving the management of scientific research funds," the Shanghai Municipal Finance Bureau and the Science and Technology Commission issued the "Notice on the management of scientific research project funds in Shanghai" to more effectively implement the relevant provisions of the State Council in Shanghai. This step-by-step implementation from the central to the local level is another characteristic of China's funding institutions.

China's funding institutions can be divided into three levels: First, funding at the central government level, including the Ministry of Science and Technology, the Ministry of Education, and the National Development Commission; second, funding at the local level, including the science and technology agencies and finance bureaus of local provinces and cities; and finally, some private organizations and enterprises which offer their own funding[339].

339 National and local level funding programs are commonly referred to as "vertical research funding programs" (original term: 纵向科研项目). These programs conduct research with funds disbursed by high-level institutions and competent government authorities. In contrast, programs developed by enterprises and other institutions are known as "horizontal research funding programs" (original term: 横向科研项目). One of their characteristics is that enterprises and other institutions provide funding to universities and other research entities, which conduct the research. In some cases, research is conducted in collaboration with enterprises, and in other cases, research is conducted on request. Depending on the contract, the results often belong to the party that provided the funding. On a smaller scale, there are also internal funding programs within universities, where university faculties provide support for a portion of their own budgets as expenses.

This report will only address central government funding[340].

In terms of type, funding can be broadly divided into two categories: government science and technology development programs and NSFC programs. Based on their characteristics, the former can be considered science and technology programs focusing on key national demands, and the latter free exploratory basic research programs. In China, the former is called “big science” and the latter “small science.”

(1) Strong involvement of the State

As mentioned when discussing the establishment of funding institutions, owing to China’s unique political and economic system and historical circumstances, funding through science and technology programs was directly led by the government from the beginning. However, the current funding institutions were selected based on the changes in the economic system after the Chinese economic reform and the demand for the development of scientific research. They were developed based on the advice of a group of scientists, approved by the central government, tested, and deemed successful.

The Ministry of Science and Technology is the agency at the center of funding institutions. Although it is committed to the development of science and technology talent and is a familiar presence for researchers, we must not forget that it is a government bureaucratic agency. In coordinating the relationship between the government and science, the Ministry of Science and Technology’s priority is bound to be the goals and demands of the State. This circumstance makes the involvement of the State in funding institutions inevitable.

Approximately every five years, the Chinese government formulates a “science and technology development plan” to set forth the specific science and technology goals it wishes to achieve and the strategies and plans for achieving them. In other words, the plan provides a direction for development over the five years. The science and technology goals identify the technologies and industries that will be emphasized and the funding projects that will be focused on. The more important a project is to the national strategy, the stronger the government’s initiative and involvement tend to be.

(2) Considerable power of scientists and experts

The power of groups of experts, mainly scientists, in the formulation of various policies and in the implementation and evaluation of projects is significant. There are three main situations in which experts are involved in funding programs.

The first is participating in the formulation of national medium- and long-term programs and major policies and providing the necessary advice. The second is providing expert advice on critical issues related to funding institutions and being involved in the overall design of the system. The third is reviewing and evaluating funding projects (conducting peer evaluations).

When funding institutions were fist established, the role of experts was primarily to provide advice. In China, where the basis of science is weak, the wisdom of scientists is very valuable, as exemplified by Twelve-Year Plan of 1956; the 1963-1972 Ten-Year Science and Technology Plan of 1963; and the National Medium- and Long-Term Program

340 Once we understand funding institutions at the central level, funding at the local level (including the departmental level) is a development of those institutions and, thus, in effect, shares their core content. Other funding institutions are considered too small in number and size to be addressed here. Therefore, this report will only address funding institutions at the central government level.

for Science and Technology Development. Groups of experts provided appropriate advice on the formulation of these plans and steadily fulfilled their role as an aid to the government.

This system began to change with the National High-tech R&D Program (commonly known as the 863 Program; this name will be used below), which will be discussed in a later section. The 863 Program originally began at the suggestion of such prominent scientists as Wang Daheng and Wang Ganchang. These scientists also participated in the 863 Expert Committee and the 863 Project Supervisory Committee, and as they became more involved in the various projects, their position as mere advisors began to change. Currently, they are tasked with reviewing and evaluating funding projects as well as being involved in all aspects of science and technology planning and policy formulation, and their role has become much larger.

5.2.2 Current status of funding institutions

In the over 40 years since their establishment, funding institutions have changed and developed in many ways.

The current funding institutions can be described as integrating science and technology planning focused on the critical needs of the nation (big science) and original and free exploration (small science). The situation, which had been heavily biased in favor of big science, has begun to change since the Xi Jinping administration came to power. Today, there is also a great emphasis on small science, particularly basic research.

The Xi Jinping administration has raised the innovation-driven development strategy to the level of law, rather than mere policy, by explicitly codifying it in the Progress of Science and Technology Law (amended in December 2021 and in force from January 2022). To innovate means to create something new. Therefore, R&D of original products and technologies have become important. Traditionally, most R&D funds were used for basic research, applied research, and experimental development. Importance was placed on technologies that could be converted into scientific and technological achievements, technologies with high applicability, and technologies that could contribute to industry, and only about 5% of total funds were used for basic research (see 3.1). Since China's science and technology and funding lag behind other countries in terms of institutionalization, the only option to catch up in a short period of time may have been to invest on experimental development. However, as mentioned in Chapter 2, basic research has become a bottleneck for China in its quest to become a global science and technology leader and has emerged as a major challenge. Aiming to promote basic research, in 2018, the State Council issued the "Opinions of the State Council on the overall strengthening of basic scientific research," whose goals included "aiming for the cutting-edge of global science and technology, strengthening basic research, deepening the reform of science and technology institutions, and promoting comprehensive innovation and development in basic and applied research." Subsequently, the "Guidelines for activities to strengthen basic research and achieve 'Zero to One'" were issued in 2020, and a new chapter on basic research was added to the Progress of Science and Technology Law in 2021. Funding for basic research is also expected to rise from the 5% to the 8% level going forward.

5.3 National Natural Science Foundation of China (NSFC) funding system

Let us begin with the funding programs developed under the NSFC.

5.3.1 Overview of the NSFC

Since its establishment in 1986, the NSFC has operated under the guidance of the CPC Central Committee and the State Council, relying on the wisdom of a group of experts and focusing on support for basic research. In 2007, the "National Natural Science Foundation of China Regulations" were enacted, and the foundation grew into an organization with systematized organizational management, process management, financial management, and supervision and security. In 2018, the "Measures to Deepen Reforms between the Party and State Institutions" placed the NSFC under the jurisdiction of the Ministry of Science and Technology rather than the State Council, making it a relatively independent organization. In principle, the NSFC is also responsible for establishing, reviewing, and supervising annual support plans and projects on its own.

The NSFC includes an Advisory Committee and a Supervisory Committee. The Advisory Committee, established on January 31, 2019, serves the role of a think-tank to provide input on the NSFC's development strategy, management structure, and funding policies and areas. The committees are chaired by members of the standing committees of each department of CAS, and their members sit on CAS expert committees or the standing committees of each department of the Chinese Academy of Engineering. The NSFC's internal organizations include the Office of Research Integrity[341], the Bureau of Planning and Policy, the Bureau of Finance, the Bureau of International Cooperation, the Bureau of Personnel, the Organization of Party Committee, the Department of Mathematical and Physical Sciences, the Department of Chemical Sciences, the Department of Life Sciences, the Department of Earth Sciences, the Department of Engineering and Materials Sciences, the Department of Information Sciences, the Department of Management Sciences, the Department of Health Sciences, the Department of Interdisciplinary Sciences, the Service Center for Administrative Affairs, the *Bulletin of Natural Science Foundation of China* Publishing Department, and the Sino-German Center for Research Promotion. The budget for FY2021 increased by 7.02% year-on-year to CNY 35.2 billion (JPY 591.36 billion[342]) because of increased investment in basic research.

As of March 2022, the NSFC has 17 funding programs in place. Details are provided in Table 12 below.

Table 12: NSFC funding programs

Funding project name	Overview
① General	The most standard program for researchers engaged in basic research. It allows researchers to independently select a topic within the scope of funding.
② Key	A program designed for researchers with a certain amount of research experience. Research topics that can be further developed with support are eligible.
③ Major	A program of research on major scientific issues related to national economic, social, scientific and technological development and national security.

341 Literally, "Office of Scientific Research Credit Building," Although there is no clear definition for scientific credit building (original term: 科研信用建設), the term is commonly considered to have two meanings: ① It indicates that the main body of a scientific research project must comply with the legal system and moral code (original term: 道徳規範) in its scientific research activities, and any discreditable acts must be punished accordingly. ② It refers to the fact that scientific research entities should pursue independent innovations in scientific research activities and actively engage in research to successfully carry out their work as contracted. See Xie Benyuan and He Xiaohui, "Two Latitudes in Scientific Credit Building," Journal of Capital Normal University: Social Sciences Edition, 2021(1):6.

342 In this report, the calculation is made assuming CNY 1 = JPY 16.8. At the time of completion of this report, CNY 1 = JPY 20.39.

④ Major Research Program	A program to fund research topics that can support national economic and social development and national security, focusing on major national strategic demands and advanced science.
⑤ International Joint Research	Programs that make effective use of international science and technology resources to help improve China's scientific research level and international competitiveness based on the principles of equality, cooperation, and shared results are eligible. This includes the Key International Collaborative Research Program and the Inter-organizational International Collaborative Research Program.
⑥ Young Scientists Fund	A program in which young researchers independently select a topic and conduct basic research within the scope of support.
⑦ Excellent Young Scientists Fund	A program to support young researchers with outstanding achievements in the area of basic research so that they can independently select their research topics.
⑧ National Science Fund for Distinguished Young Scholars	A program to support young researchers with very outstanding achievements in the area of basic research so that they can independently select their research topics and conduct innovative research.
⑨ Innovative Research Groups	A program to develop innovative research around a single important research topic, with outstanding young Chinese researchers in leadership roles.
⑩ Regional Science Fund	A program that targets areas inhabited by ethnic minorities (autonomous regions and autonomous prefectures) and some areas where scientific and technological development is lagging and provides intensive support to researchers conducting basic research in these areas.
⑪ Cooperative Fund	A program to develop research by addressing the actual demands of enterprises, regions, and various institutions as scientific problems.
⑫ Research and Production of Equipment for National Scientific Research Institutes	A program that supports the research and production of original exploratory research equipment. There are two methods to apply: free application and departmental recommendation.
⑬ Basic Science Center	A program focusing on international advanced science that brings together outstanding research personnel from China and abroad to conduct joint research and produce high-level international research results.
⑭ Specialized	Innovative research requiring timely support and science and technology activities related to the development of the NSFC are eligible. The program is divided into a research program and a science and technology utilization program.
⑮ Tianyuan Fund for Mathematics	A funding program to help scientists explore the characteristics and development laws of mathematics.
⑯ Research Fund for International Scientists	A program that supports outstanding foreign researchers who can develop basic research during their stay in China. Topics can be freely chosen within the scope of funding.
⑰ International Cooperation and Exchange	A program that aims to lay the foundations for developing joint research by conducting exchange activities with science funding organizations and scientific research institutes outside of China.

(Source: Prepared by the authors based on various sources)

Of course, in addition to the above funding programs under the NSFC, several new programs are added each year. For example, in 2021, the "Original Exploration Program" was developed in response to the "Opinions of the State Council on the overall strengthening of basic scientific research" and "Opinions on deepening project evaluation, talent evaluation, and institutional evaluation reform." Each funding program also includes several thematic sub-projects. Take the Key International Collaborative Research Program, for example, where different topics are developed for projects with South Korea, Japan, and so on. Every year, an application guide is provided for each project, allowing researchers who meet the requirements to apply.

5.3.2 Funding project application process

The application process is briefly described below. Although not explicitly stated, over the past few years, the NSFC has issued an application guide around January each year. Applicants must submit application materials through the NSFC's Internet-based Science Information System (ISISN)[343]. In addition, the system is such that the application itself cannot be submitted without selecting the institution to which the applicant belongs (below, "host institution"). If an applicant does not see their institution in the selection list, they must first register their host institution in the system. Host institutions eligible for registration are universities, scientific research institutions, or public interest organizations with independent legal entity status and engaged in basic research located in China[344]. The host institution must first check the application materials of the applicant for omissions and formatting errors. Once the host institution determines that the materials are satisfactory, the applicant may submit the application to the ISISN system.

Applications are reviewed in three steps: an initial eligibility check, a mail review, and panel review. The initial eligibility check is a formal review. Reasons for denial include the following: ① The applicant does not meet the application requirements; ② The application materials are incomplete; ③ The number of funding projects applied for by the applicant is greater than specified (when there is a limit on the number of applications). If none of these cases apply, the application is deemed eligible. Once the application has passed the eligibility check, it goes through to the main evaluation, that is, a mail review conducted by three experts randomly selected by the NSFC from its expert database. Of course, systems such as designating experts to be excluded due to conflicts of interest (original term: 专家回避制度) are applied. Experts may also be excluded at their own request, when they are unable to concentrate on the review due to ill health, workload, or other reasons. At this point, the three experts must conclude whether to approve or reject the proposal, and in case of approval, they must explain the academic perspectives that support their conclusion in a panel review attended by a larger group of experts. These academic perspectives should include ① scientific value, ② potential for innovation, and ③ positive impact on society, as well as the feasibility of the research plan. In some cases, the applicant's research background, plans for the use of funds, and other funding support received should also be considered. After hearing the explanations of the three experts, the other experts attending the meeting vote for or against the proposal (majority vote). Once the selection process is concluded, the applicant and the host institution are notified of the results in writing.

Although the above is the ordinary process, there are exceptions. If the project is a temporary addition due to special demands of national economic and social development, and not enough time is available, either a mail review or a panel review will be selected. In addition, innovative projects with strong originality can be brought to the panel review even if they are not selected in the mail review, as long as they receive signed recommendations from two

343 https://isisn.nsfc.gov.cn

344 The special administrative regions of Hong Kong and Macau are also included. However, no host institutions from Macau are registered in the ISISN system.

experts who will participate in the panel review.

Deadline constraints also exist for each step of the process. First, the application guide for each project must be published at least 30 days prior to the start of the application process. The initial check must be completed within 45 days after applications are closed. Applicants and host institutions notified of selection must submit a project plan within 20 days of receiving notification, based on the experts' review opinion (feedback) and the amount of support. The caveat here is that no changes should be made except for those items that have been instructed to be modified. In addition, support funds are disbursed to the host institution, which must confirm receipt to the NSFC and the applicant within 7 days of receipt of the funds. Applicants who wish to appeal a decision of ineligibility or rejection must file a written request for secondary review with the NSFC within 15 days from the date of receipt of the notification. The NSFC must complete the secondary review and notify the applicant and the host institution of the results within 60 days of receipt of the application for secondary review.

After receiving the funds, the host institution must proceed with the research in accordance with the research plan and must document the process of the research and report its progress to the NSFC in the form of annual reports. Once a project is selected, the applicant becomes the person in charge of the project. The person in charge cannot be changed except in special cases. These special cases include ① the occurrence of circumstances that make it impossible to continue the research, ② no longer belonging to the host institution, and ③ research misconduct being discovered. If, in the course of conducting the research, the person in charge determines that major changes are needed in the research or research plan, they must obtain approval from the NSFC through the host institution. At the end of the period of support for a project, within 60 days of the end date, the person in charge must submit a final report through the host institution to the NSFC, along with a report of research results, if the project has produced such results. The submitted final report and results report and a summary of the research will be made publicly available through the NSFC Big Data Knowledge Management Service Portal[345] and will be accessible to general users without login.

5.4 Basic framework for national science and technology programs

As noted above, the NSFC plays a central role in funding projects related to basic research. However, these are not the only funding projects being developed at the central government level. In addition to the NSFC, as shown in Table 10, there are the ① National Science and Technology Major Projects, ② National Key R&D Program of China, ③ Technology Innovation Guidance Program, and ④ Base and Talent Program.

5.4.1 National Science and Technology Major Project

National Science and Technology Major Projects are projects that aim to complete major strategic products and major processes of key general-purpose technologies (original term: 共性技術) *within a certain period of time* (emphasis ours) through breakthroughs in core technologies and concentration of resources to realize national goals. The

345 https://kd.nsfc.gov.cn/

National Science and Technology Major Projects include 16 programs[346]. Since the programs are implemented under a policy of sequential progression, starting with those for which the conditions are met, the start date is different for each one. For some programs, application guides have yet to be created. In addition, many projects have been developed under the umbrella of each program. The difference from the NSFC programs in that in the case of National Science and Technology Major Projects, the timing of when the application guide is released is uncertain, as the program start date is determined based on a comprehensive consideration of national development demand and maturity of the implementation period. The CPC Central Committee and the State Council have the authority to decide what programs to select. In the implementation phase, the Ministry of Science and Technology takes the lead, with the Development and Reform Commission and the Ministry of Finance both cooperating.

The programs implemented in the National Science and Technology Major Projects are arguably the areas of funding that China has been focusing on the most in the past few years. The key areas of science and technology development through 2020 were defined in the Outline of the National Medium- and Long-Term Program for Science and Technology Development (2006-2020). In 2017, the Ministry of Science and Technology, the Development and Reform Commission, and the Ministry of Finance (below, the “three departments”) jointly formulated the “Regulations for the management of National Science and Technology Major Projects,” which govern each program and the projects under its umbrella.

In the case of a National Science and Technology Major Project, because of its large scale, multiple organizations are required to manage and operate the project. First, the three departments hold an interdepartmental management meeting[347] to formulate a development plan for the overall operation of the program, establish relevant policies to realize the plan, and review the budgeting process. In addition, a specialized agency[348] is selected and entrusted with detailed administrative tasks, including clerical work and serving as a point of contact. Specialized agencies are involved in a wide range of activities, such as receiving applications for projects from applicants, transferring funds, checking the progress of projects and performing acceptance inspections, managing documents and records, and advising on the establishment of application guides. A series of procedures related to signing contracts with the project’s host institution are also carried out by the specialized agency. Since the three departments are responsible for many tasks other than the National Science and Technology Major Projects, specialized agencies perform some of the tasks on their behalf and act as intermediaries between host institutions, the three departments, and the CPC Central Committee to coordinate the necessary tasks while also ensuring the smooth progress of the project.

Since the 11th Five-Year Plan for National Science and Technology Development in 2006, a plan is issued every five years to present the key scientific fields for the following five years. The five-year plan acts as a compass for the science and technology industry and is an important policy that provides immediate information on the direction and prospects for scientific and technological development, key areas, and bottlenecks in science and technology. The 14th Five-Year Plan for National Science and Technology Development was expected to be released in 2021. However, owing to various reasons, it has not yet been published as of March 2022.

346 Standard as of February 25, 2022.

347 A central meeting conducted by the management departments, that is, the three departments mentioned above. Important decisions are made at this meeting.

348 A specialized agency (original term: 专业机构) is a third-party organization that performs administrative tasks related to funding projects. The three departments select candidate agencies and decide on them at the interdepartmental joint meeting.

National Science and Technology Major Projects will be selected in five fields: growth of high-tech industries, improvement of traditional industries, bottleneck issues in national economic development, improvement of national health level, and national security. The projects will be selected based on the following five criteria: ① Strategic industries that meet the needs of economic and social development, lead to the formation of independent intellectual property rights for key technologies, and serve as a driving force for improving the independent innovation capabilities of enterprises; ② Key basic technologies that have a significant impact on the overall improvement of industrial competitiveness; ③ Projects that resolve key bottleneck issues in economic and social development; ④ Projects that are of great significance for improving national security and overall national strength by realizing military-civilian integration and military-civilian transformation; and ⑤ Projects that are compatible with China's national circumstances and commensurate with its national strength. As of March 2022, the publicly available National Science and Technology Major Projects include the following programs.

① Critical electronic components and high-end general-purpose chips and underlying software
② Ultra-large scale integrated circuit manufacturing and set technology
③ Next-generation broadband and mobile communications
④ High-grade NC machine tools and base manufacturing technology
⑤ Development of large oil fields, gas fields, and coalbed methane
⑥ Large advanced pressurized water reactors and high-temperature gas cooled reactors for nuclear power
⑦ Water pollution management and control
⑧ Breeding new varieties of genetically modified organisms
⑨ Development of important new drugs
⑩ Prevention and treatment of communicable diseases such as AIDS and viral hepatitis
⑪ Large aircrafts
⑫ High-resolution Earth observation systems
⑬ Manned spaceflight, lunar exploration projects, etc.

The introduction and progress of each project can be found on the official website of the National Science and Technology Major Projects[349].

As the name implies, all of the programs are significant. Therefore, each program includes numerous sub-projects. These projects can be divided into ① directed contract projects (in which the host institution for the project is predetermined); ② directed competition projects (in which only certain host institutions that meet the requirements are eligible to participate, and the host institution is selected through expert evaluation); and ③ open competition projects (in which the host institution is selected through comprehensive evaluation in accordance with the principle of selecting the best candidate in an open competition). Project implementation is carried out in cooperation between the leader institution and the participating institutions. In the case of directed contract projects, the leader institution is appointed in advance by the national government and can then organize the participating institutions at its own discretion. Of course, it is still necessary to comply with the requirements of the application guide. A directed competition project is a method in which the government, through review and evaluation, selects a leader institution and participating institutions to proceed with the project. Since the majority of open competition projects consist of

349 http://www.nmp.gov.cn/

topics that are developed from directed projects, they are often absorbed into directed projects as soon as the host institution is determined. As an example to aid in understanding, under "Development of important new drugs," which is one of the programs of the National Science and Technology Major Projects, directed competition projects include "research and development of traditional Chinese medicine formulas based on classical books," whereas open competition projects include "research and development of new traditional Chinese medicine drug varieties and core innovation technology" and "research on internationalization of traditional Chinese medicine and biomedicine varieties." These open competition projects fall under the category of R&D in traditional Chinese medicine and are, therefore, managed as projects under the umbrella of the directed competition project.

In addition, in 2021, the Ministry of Science and Technology released the new "Science and Technology Innovation 2030 Major Projects," which were added to the already released National Science and Technology Major Projects. These projects were established with the following goals. First, to build an industrial technology system with international competitiveness; to strengthen the fields of modern agriculture, next-generation information technology, smart manufacturing, and energy as an integrated plan; to promote disruptive technological innovation; and to drive industrial transformation as quickly as possible. The projects also aim to develop a technological system that supports sustainable development and the improvement of people's livelihood and to break through bottlenecks and constraints in areas such as resource environment, population and health, and public safety. Another goal is to build a technological system of national security and strategic interests and to develop strategic high technology in the fields of deep sea, subterranean, deep space, and information security. The projects under this umbrella include ① independent innovation in the seed industry; ② green and highly efficient use of coal; ③ smart power grid; ④ global integrated information network; ⑤ big data; ⑥ smart manufacturing and robotics; ⑦ key new materials R&D and application; ⑧ Beijing-Tianjin-Hebei integrated environmental management; and ⑨ health security.

In order to apply for any of the projects, application materials must be submitted through the National Science and Technology Information System Public Service Platform[350].

5.4.2 National Key R&D Program of China

The National Key R&D Program of China aims to overcome technological bottlenecks in key areas of national economic and social development, including research of significant social benefit in the civilian sector and critical science and technology issues related to industrial innovation competitiveness, independent innovation capabilities, and national security.

The National Key R&D Program of China was created by merging the existing National Key Basic Research and Development Program (commonly known as "973 Program"), National High-tech R&D Program (commonly known as "863 Program"), National Key Technologies R&D Program, and International Science and Technology Cooperation and Exchange Project, as well as the Industrial Technology Research and Development Fund jointly administered by the National Development and Reform Commission and the Ministry of Industry and Information Technology (original term: 工业和信息化部, commonly abbreviated to "MIIT") and the public interest industry research projects administered by 13 departments, including the Ministry of Agriculture. The program is ultimately under the

350 https://service.most.gov.cn/index/

supervision of the Ministry of Science and Technology. Since it was established by consolidating many programs into one, the program includes too many projects to list them all individually. In 2021, 82 project application guides were published[351].

As the cycle of conversion from science to technology and from technology to market gradually shortens, the boundaries between science, technology, and market are becoming blurred, and the conversion of scientific results and the updates of technology are accelerating. In order to respond to such technological and industrial changes, the National Key R&D Program of China was launched with the idea of creating and managing a single chain of basic research fields, major general-purpose technologies, and actual applications.

In addition, according to the importance and scale of the research topic, the projects are divided into "Major Special Projects" and "General Projects," and each project includes several tasks as sub-projects. The National Key R&D Program of China as a whole has chosen a management method that blends bottom-up and top-down approaches. In other words, when selecting topics, the Ministry of Science and Technology first surveys regions and organizational divisions to ascertain what is actually in demand. Next, each project of the National Key R&D Program of China is established based on a comprehensive consideration of demand from the research field based on the surveys and major national strategies. This is an important and essential process set forth in the "Provisional methods for the management of the National Key R&D Program of China" established in 2017 by the Ministry of Science and Technology and the Ministry of Finance.

The implementation period of Major Special Projects is five years, unless there are exceptional circumstances. When selecting the host institution, in principle, the open competition method through comprehensive evaluation is adopted. The application must specify who is in charge of the project, and the person in charge must have research skills, leadership skills, appropriate age, and a high level of scientific credit. In some cases, when an urgent and sudden demand for major national science and technology is recognized, a project may be entrusted to a designated host institution.

As with the National Science and Technology Major Projects, specialized agencies are tasked with supervising the work and managing each project in the National Key R&D Program of China. As in NSFC and National Science and Technology Major Projects, project applications are submitted online through the National Science and Technology Information System Public Service Platform[352], and the initial check is a formal review, which is handled by a specialized agency. When the applicant-to-acceptance ratio is less than three to four times, the initial check can be avoided. The first round of reviews is conducted by experts registered in the National Science and Technology Expert Database, with a choice of online, mail, or panel review. Host institutions that pass this review proceed to the second round of the main review, which is a defense review (interview) of team members.

After the project is officially confirmed, the host institution is obligated to report on the progress of the project in November of each year (except for projects that have started within the last three months). In addition, an interim inspection is conducted for projects that have been underway for more than three years. After the project is completed, the host institution must submit acceptance inspection documents within three months of the completion date, and the specialized agency must organize experts to complete the acceptance inspection within six months of the submission.

351 https://service.most.gov.cn/sbjhyl2021zy/

352 https://service.most.gov.cn/index/

Samples and prototypes produced by projects that have passed the acceptance inspection, as well as papers and books published on the basis of their results, must be clearly labeled as "Supported by the National Key R&D Program of China."

5.4.3 Science and Technology Innovation Guidance Program and Base and Talent Program

The Science and Technology Innovation Guidance Program and Base and Talent Program are funding programs in which the central government provides direction through policies and regulations and local governments take the lead in developing the programs.

(1) Science and Technology Innovation Guidance Program

The Science and Technology Innovation Guidance Program is a program established to encourage innovation. It is a funding program that strengthens support for corporate innovation, particularly corporate innovation in small and medium-sized enterprises, as well as science and technology incubation and entrepreneurship by human resources, especially university students and young researchers, based on the policy of "mass entrepreneurship and innovation for all." In 2014, the State Council enacted the "Proposal on the reform of the management of scientific research programs funded by the central government," which stipulates that the Science and Technology Innovation Guidance Program should "play the role of a fiscal fund, support science and technology innovation activities, and promote the capitalization and industrialization of science and technology achievements by means of risk reduction, ex-post subsidies, and promotion of innovation and investment." Ex-post subsidies are an approach in which the scope of funds to be provided is not determined from the beginning. Instead, the funds actually used in the scientific research activities are subsidized after the project is completed through evaluation of scientific and technological results and research activities. This policy of the State Council was formulated in more concrete terms in the "Methods for government-led management of funds for local science and technology development projects" established by the Ministry of Finance and the Ministry of Science and Technology in 2016. This document stipulates that the central government will "provide support with specific project funds to regions that focus on enhancing their own innovation capabilities by improving basic conditions for scientific research, creating an environment for scientific and technological innovation, supporting advanced scientific and technological work, and promoting the conversion of results." The regions will then guide science and technology innovation through various policies and methods, such as reducing the cost of starting a business, providing tax incentives for small and medium-sized enterprises engaged in science and technology innovation activities, and minimizing the risk of starting a business while attending university, according to the actual circumstances of the region.

Below are some examples from provinces and cities.

① In 2021, Jiangxi Province implemented a Collaborative Science and Technology Innovation Promotion and Planning Project. The province supported host institutions that were able to implement joint projects with international science and technology organizations and other regions of the country. Specifically, the projects were divided into the following categories: joint projects with developed countries, joint projects with Africa, joint projects with other ministries, and joint projects with neighboring regions. Research themes to be supported were announced for each of these categories. This was an attempt to improve the situation of the province, which is geographically located in central China, where exchanges and cooperation with other countries are less frequent than in coastal areas, and to take advantage of the benefits of being connected to regions with developed science and technology, such as Guangdong and Zhejiang provinces.

② In 2021, Chenzhou City developed a Science and Technology Innovation Capability-building Project as a science and technology innovation promotion program to improve the city's capabilities. The project supported applied basic research and clinical medical technology research. It appears that the city's policy is to steadily expand in areas that are considered fundamental to scientific and technological innovation.

③ In 2018, Hebei Province launched a Technology Innovation Promotion Program to create community-building projects for Beijing City, Tianjin City, and Hebei Province. The projects include the "construction of a science and technology innovation service platform," "industrial innovation promotion," and "research and application of general-purpose technologies in the field of social development." Hebei Province has a lower level of economic, scientific and technological development than direct-administered municipalities such as Beijing and Tianjin. However, the Beijing-Tianjin-Hebei area is the most important region in China's social development due to its role as the capital region, and the province is a policy beneficiary on par with Beijing and Tianjin. Strengthening ties with Beijing and Tianjin could be an excellent opportunity to improve the province's scientific and technological innovation capabilities while leveraging the resources of Beijing and Tianjin.

Thus, Science and Technology Innovation Guidance Projects are being implemented in each region in various ways that, together with development strategies, capitalize on local strengths and compensate for weaknesses.

(2) Base and Talent Program

The Base and Talent Program is a funding program that aims to improve regional innovation capabilities by utilizing local resources, building science and technology innovation bases, and fostering excellent research personnel.

Science and technology innovation bases are high-level research centers that concentrate science and technology personnel and equipment, such as key laboratories, engineering centers, R&D centers, technology research centers, and public service platforms, and are entrusted with science and technology research projects. In 2020, the Sichuan Provincial Commission of Development and Reform issued a "Notice on the implementation of the project to construct engineering research centers and engineering laboratories in Sichuan Province." This notice stated that the province would support universities and research institutions conducting research in key science and technology areas such as 5G, big data, AI, blockchain, and biomedicine in establishing engineering research centers and laboratories. Support would be given to research bases meeting the following criteria: ① a research space of at least 1,500 m^2; ② research equipment worth at least CNY 10 million; ③ at least 20 researchers; ④ independent intellectual property in at least five areas of the relevant industry; and ⑤ collaboration agreements for industrial research signed with two or more provincial innovation platform construction bases.

The talent part of the program mainly refers to support for young research personnel. For example, the 2021 Science and Technology Base and Talent Program in Guangxi Zhuang Autonomous Region selected the "Young Innovative Talent Scientific Research Project," the "Young Innovative Talent Development Project for Science and Technology in Impoverished Areas," and the "Young Innovative Talent Development Project for Public-Interest Scientific Research" to support outstanding research talents. In the case of the Young Innovative Talent Research Project, young researchers under the age of 40 years (45 years in the case of medical majors), with doctoral degrees from high-level universities within or outside China, and with less than three years of work experience in Guangxi Zhuang Autonomous

Region are eligible for support. The Young Innovative Talent Development Project for Science and Technology in Impoverished Areas aims to support young researchers who will work as full-time researchers after July 5, 2019, in counties of Guangxi Zhuang Autonomous Region designated as impoverished areas in the 12th Five-Year Plan. The Young Innovative Talent Development Project for Public-Interest Scientific Research supports research teams working at universities and research institutes that conduct scientific research of public interest, provided that the leader is under 40 years of age, the research team has been working together for a long period of time, and it has achieved joint research results.

Talent programs contribute to correcting the tendency for outstanding human resources to concentrate in large cities such as Beijing, Shanghai, and Guangzhou, which makes securing human resources one of the major challenges in rural areas. In recent years, regions have been reviewing salaries, enhancing benefits, and offering a variety of funding projects in order to secure human resources, and are trying to halt the trend of human resources concentrating in large cities.

In addition to the central government funding projects described above, other projects are developed independently by provinces or promoted by various research institutions, enterprises, and universities. In China, funding projects not only provide material security to researchers engaged in science and technology research but they are also an important research achievement and a valuable resource to continue research. According to the Ministry of Science and Technology's "Analysis of the Development Status of R&D Personnel in China in 2019," R&D personnel in 2019 increased to 4,801,000 people. Given the number of researchers, funding projects are not yet sufficient. Of course, there are many aspects that do not simply depend on the number of funds and funding projects being invested in. However, the central government's emphasis on and support for scientific research is expected to be very fruitful.

5.5 Reform of funding institutions

Since the Xi Jinping administration came to power, the issues of basic research and science and technology management have been in the spotlight as never before, and funding institutions have changed as well. Some of the reforms introduced through successive guiding opinions have already been mentioned above. In this section, however, we will take a closer look at funding institutions in particular.

5.5.1 Positioning of basic research

As mentioned above, the emphasis on basic research has manifested itself in recent policies and legislation as well. These policies are extremely important because they have a direct impact on funding institutions.

First, the "Guidelines for activities to strengthen basic research and achieve 'Zero to One'" issued by the Ministry of Science and Technology and others in 2020 stated that the Ministry would promote systems for the evaluation of representative works in order to create an evaluation system that encourages fundamental innovation. This method would evaluate the scientific level and scholarly contribution of representative works, rather than the number of papers. The government also adopted a periodic evaluation and classified review system for State Key Laboratories and established an evaluation system focusing on the quality of innovation and academic contribution, with national missions, status of results, and effectiveness of innovation as important evaluation criteria. In addition, the government stated that it would support higher education institutions and scientific research institutes in planning basic research independently. In terms of funding projects, based on the requirement to improve and reform project formation mechanisms, the government set out to improve the formation style of national key basic research projects in terms of guide creation style, effective competition, openness, project review mechanisms, and formation of review expert teams. Although the central government has stated the importance of basic research, it has not taken any noteworthy initiatives to date. However, this policy has attracted attention because it fully emphasizes basic research, and it declares that basic research will be strengthened in earnest going forward.

The following year, for the first time in 14 years, an amended version of the Progress of Science and Technology Law was enacted, and an entire chapter was devoted to basic research. The placement of the chapter on basic research right after the general provisions is partly an indication of the change in the position of basic research, which is taking a central role in China's science and technology innovation system. For a long period of time, investment of funds in basic research was limited to about 5% of total research investment. However, through this law, the government strengthened financial investment and announced that enterprises investing funds in basic research would receive financial, monetary, and tax support. Therefore, investment in basic research is expected to increase more than ever before. The law has been in effect since January 1, 2022, so it is still too early to gauge its effectiveness. However, it will be interesting to see how it will synergize with the Ten-Year Plan for Basic Research and the 14th Five-Year Plan for Science and Technology Innovation, which are expected to be released this year and show significant progress.

5.5.2 NSFC reform measures for FY2021

Based on the guiding philosophy of the Xi Jinping administration regarding science and technology innovation and basic research, the NSFC stated that it would take the following reform measures and establish new funding institutions starting in 2021.

(1) Conduct classified evaluation

Scientific problems to be studied will be assessed through classified evaluation based on a division into four types: ① original research, ② cutting-edge research, ③ research to overcome bottlenecks, and ④ research related to general-purpose technology. In addition to the 2020 Key Projects and General Projects, the Youth Science Fund projects were also newly included in classified evaluation. Applicants should select among the four programs the one that most closely matches the nature of their project and explain their reasoning.

(2) Establish a support system for human resources

The NSFC will increase the scale of funding for Youth Science Fund projects and strengthen support for projects financed by the National Science Fund for Distinguished Young Scholars. The goal is to adjust the management process of National Science Fund for Distinguished Young Scholars projects, improve the evaluation system, and provide stable support for basic science. The NSFC announced that it will continue to accept applications from foreign (non-Chinese) applicants to National Science Fund for Distinguished Young Scholars and Youth Science Fund projects, actively attract outstanding young talents to return to (or visit) China and strengthen the function and support of Research Fund for International Scientists projects.

(3) Continue the Original Exploratory Program

The NSFC stated that implementation of the Original Exploratory Program would continue in 2021. The program would select a number of highly original projects that were “high-risk, not yet widely recognized, and potentially disruptive.”

(4) Use new application codes at the time of submission

To create a new evaluation system, the NSFC set out to simplify the code application process and improve the management of application codes while listening to a wide range of opinions.

(5) Promote integration of different research fields

In interdisciplinary research on comprehensive and complex issues in different fields, the NSFC will explore new research paradigms, raise the level of interdisciplinary research capabilities, produce results with global impact, and promote the development of interdisciplinary human resources capable of integrating different fields.

(6) Conduct RCC (Responsibility, Credibility, and Contribution) reviews

To improve the quality of review and evaluation, the NSFC decided to continue to conduct RCC reviews. The meaning of RCC is explained below.

Responsibility: The experts engaged in reviews have a responsibility to both the NSFC and the applicants, so first and foremost, it is important to fulfill that responsibility. To the NSFC, experts have a responsibility to ensure that the NSFC can select and support truly outstanding proposals. To the applicants, experts have a responsibility to help the applicants to refine their research ideas and plans.

Credibility: It is also crucial to maintain credibility, which experts accumulate by participating in the review process over a long period of time. A record of the status of the expert’s reviews is permanently stored in the system.

Contribution: This includes providing detailed, clear, and informative feedback of significant value to the NSFC and providing enlightening and constructive feedback to the applicant that is clear, well-reasoned, and well-founded. Experts’ contributions in the review process are incorporated into their credit record.

The purpose of implementing the RCC evaluation system is, first of all, to encourage and evaluate the contributions of experts in the review process by providing guidelines to experts engaged in review and by clarifying the responsible code of conduct for experts. This system also aims to improve the quality of the review process and build a good academic ecosystem by allowing experts to establish long-term academic prestige through responsible reviews. Experts should conduct reviews in accordance with various project management regulations, including the “Measures for the management of exclusion and confidentiality in National Natural Science Foundation project reviews,” “Measures for the management of expert services in National Natural Science Foundation project reviews,” and “Code of conduct for experts in National Natural Science Foundation project reviews,” as well as the 2020 Review Service Guidelines and other documents. In the review process, reviewers must pay attention to ① expertise in science, ② understanding of NSFC policies, ③ prohibition to pursue private interests in compliance with conflict of interest rules, ④ integrity, ⑤ confidentiality, ⑥ responsible feedback as described above, and ⑦ inclusiveness that emphasizes original ideas and cross-disciplinary research.

(7) Ensure diversity of funding investments and promote collaborative innovation

As of December 2021, 23 provinces (including autonomous regions and direct-administered municipalities) have already become members of the Joint Fund for Regional Innovation and Development[353], and 9 enterprises have become members of the Joint Fund for Corporate Innovation and Development[354]. In addition, 5 industries have established a Joint Fund for Industries of the New Era[355], which has shaped the joint fund support system for a new age to some extent. In 2021, the NSFC aimed to build on these initiatives to encourage social and individual donations, diversify investment entities, and further expand the scope of matching funds.

(8) Promote fund management reform

In addition to the National Science Fund for Distinguished Young Scholars, projects under the new Excellent Young Scientists Fund will adopt the lump-sum system (a system to increase the flexibility and autonomy of researchers by avoiding restrictions on the percentage and use of funds). This system allows project leaders to use their funds within the stipulated limits without separating direct and indirect costs. In other words, when submitting an application, the applicant must provide a reasonable budget amount in accordance with the basic principles of relevance to goals, consistency with policy, and economic rationality, but they are not required to compile a detailed budget.

(9) Simplify the application process

Paper-based applications have been eliminated and converted entirely to online applications, so that applicants only need to attach and upload the necessary documents through the online application. Submission of materials at a later date is also reduced as much as possible.

(10) Strengthen management of host institutions

The NSFC stated that it will improve the entry and exit system for host institutions, provide them with dynamic management, establish a credit evaluation system for host institutions, and link credit evaluation to the assessment of indirect costs and incentives or punishments.

(11) Promote the creation of a positive academic culture around science funds

The NSFC stated that the basis for “education, motivation, regulation, supervision, and discipline” is to create a positive academic culture. It announced that during the 14th Five-Year Plan period, it will work to firmly establish and develop an academic culture based on education, guided by motivation to go in the right direction, founded on regulation, and using supervision as a cue and discipline as the last resort, as well as research ethics for science funds.

353 Original term: 区域创新发展联合基金. The fund, co-financed by the NSFC and local governments, aims to strengthen basic and applied basic research through studies that cut across research areas and regions, enhancing local innovation capabilities and contributing to local economic development.

354 Original term: 企业创新发展联合基金. The fund, co-financed by the NSFC and enterprises, aims to improve the innovation capabilities of enterprises by conducting basic research on core scientific issues and central-purpose technologies in response to the demands of industrial development.

355 The funds are jointly established by the NSFC and industry partners (e.g., the China Meteorological Administration in the case of the Joint Fund for Meteorology). The goal is to develop the industry, strengthen basic research in the industry, and develop core technologies. There is a Joint Fund for Meteorological Research, a Joint Fund for Railway Basic Research, a Seismological Science Joint Fund, a Joint Fund for Nuclear Technology Innovation, and a Joint Fund for Civil Aviation Research.

5.5.3 Reforms in the use of funds

Today, funding projects have much more freedom than in the past in the use of research funds. As mentioned above, in 2021, the State Council issued the “Opinions on the reform and improvement of fund management for scientific research funded by the central government,” which also applied to the management of expenses for funding projects. In other words, the State Council decided to expand the autonomy of scientific research fund management, simplify budgeting, and prepare budgets for direct costs according to three categories: equipment costs, operations costs, and labor costs. The authority to adjust labor and operation costs was transferred to the project leader, and the scope of the lump-sum system for funding was expanded to include funding projects related to basic research and personnel[356].

The proportion of indirect costs can be increased to offer greater incentives to researchers with high contribution. For purely theoretical basic research projects such as mathematics, the proportion of indirect costs can be increased up to 60%. For other projects, the proportion of indirect costs can be up to 30% for funding up to CNY 5 million, 25% for funding of CNY 5 to 10 million, and 20% for funding of more than CNY 10 million.

To reduce the administrative burden on researchers, a financial assistant is assigned to each project, and the necessary personnel costs can be covered through adjustment of project funds or other avenues.

These reforms are very significant changes for researchers. In particular, the reforms related to direct and indirect costs deserve a special mention. Previously, direct costs included labor (personnel), equipment, energy and material[357], experiment, travel, meetings, intellectual property protection, and administrative costs. Indirect costs included expenses that were not covered by these items. Indirect costs consisted mainly of performance-based pay (equivalent to bonuses and incentives) paid to encourage researchers, costs associated with securing research space and the associated utilities, and equipment maintenance costs. Many expense items had to be budgeted in detail, and there were strict regulations such as a cap on the amount of funding that could be spent on each item and the requirement to attach receipts to every item. However, that has changed significantly with this reform. Since the proportion of indirect costs has increased (up to 60%), monetary incentives for researchers (also known as incentive pay) are also likely to increase. Direct costs have been reorganized into three categories: equipment costs, operations costs, and labor costs. Receipts are no longer required except for the purchase of equipment costing CNY 500,000 (approximately JPY 8.4 million) or more. In addition, increases or decreases in equipment costs can now be independently adjusted by the host institution without administrative review, and other funding adjustments can be made at the discretion of the project leader. Before the reform, residual funds after completion of the project had to be used within two years, and if they were not used, they had to be refunded after explaining the reason. However, this rule was also abolished with the reform, and residual funds can now be used by the host institution without any time limit.

[356] In the case of the NSFC, projects developed under the umbrella of the Youth Science Fund Program, the Outstanding Youth Science Fund Program, the National Outstanding Youth Science Fund Program, the Innovation Research Cluster Program, and the Basic Research Center Program are eligible.

[357] This refers to the costs incurred in purchasing water, electricity, raw materials, fuel, parts, etc., needed for research, development, and experimentation. Postage and packaging costs are also considered energy and material expenses.

In addition, the management measures[358] established by the Ministry of Finance and the NSFC in September 2021 introduced a "contract system" and a "budget system" based on different budget management methods. For contract system projects, there is no need to prepare a project budget. The project is subsidized according to a certain range of expenses and does not need to go through the adjustment process. For budget system projects, all budget adjustment authority for equipment costs is delegated to the host institution. The project leader is required to submit applications according to actual research needs for review by the host institution but not by the NSFC. Moreover, all authority to adjust labor and work costs is delegated from the host institution to the project leader[359]. Other reforms based on these management measures include the following: paying salaries within 30 days of contract signing; allowing host institutions to use surplus funds under certain conditions and clarifying cases in which funds must be returned; and assigning a "scientific research financial assistant" to each project to relieve researchers from administrative tasks and covering the necessary personnel costs.

The above measures have not simply encouraged researchers but have also created an environment in which they can devote themselves solely to their research, as their autonomy has been expanded and the burden of administrative tasks has been greatly reduced.

5.5.4 Reforms of evaluation methods

Since funding projects select host institutions and project leaders through a competitive process, the evaluation (selection) criteria are an important factor.

There are no clear rules on what constitutes an "outstanding" researcher and suitable project leader. The 2018 "Opinions on deepening project evaluation, talent evaluation, and institutional evaluation reform" and the 2020 "Measures to eliminate the erroneous 'paper only' mentality in science and technology evaluation" and "Opinions on the appropriate use of SCI-related indicators and orientation of research evaluation in the regulation of higher education institutions" focused on "the number of papers, titles (professional experience), academic background, and awards (such as prizes received)" (the "four only" mentioned above). In the future, however, evaluation methods using the "four only" standard will be eliminated altogether, and the evaluation system will be reformed to emphasize "quality of papers, achievements, and contribution to society."

In order to evaluate the quality of papers, a system of evaluating representative works, rather than the number of papers, has been implemented. Researchers select their own representative works, not exceeding 10, whose value is then judged through peer evaluation. In addition, for research related to applied research and technological development, papers have been removed from the evaluation index. The phenomenon whereby a great deal of funds are allocated to projects related to so-called "hot research topics" has been attracting considerable attention. In an

[358] To realize the spirit of the document "Opinions on the reform and improvement of fund management for scientific research funded by the central government" and to improve the management and use of project funds in the National Natural Science Foundation of China, in September 2021, the Ministry of Finance and the National Natural Science Foundation Committee issued the "Measures for the management of project funds from National Natural Science Foundation grants." This commentary is based on "Clarifying Methods in the Contracting System and Expanding Incentives for Researchers" (March 14, 2022, Cao Xiuying, [Science and Technology Daily Reporter], JST Science Portal China, Science and Technology Topic No. 186, https://spc.jst.go.jp/hottopics/2204 /r2204_cao.html (accessed March 23, 2022).

[359] Survey responses indicated that budget adjustment authority is being delegated to host institutions, but the relationship of authority between the host institutions and project leaders is unclear. However, this reform appears to further delegate authority from host institutions to project leaders.

effort to change the situation, measures were taken to evaluate projects fairly regardless of their topicality.

In the past, in most funding projects, with the exception of projects supporting young researchers, the more important the project, the more its leader tended to be selected based on “academic background, titles, and awards.” Restrictions such as “at least n years of professional experience and PhD holders only” were imposed, which eventually led to the phenomenon of “a handful of researchers monopolizing projects.” The current reform clarifies that “restrictive conditions” will be reduced as much as possible. Basically, these measures are intended to increase incentives for researchers to conduct research. In addition to the above, a system of differentiated incentive evaluation indicators not provided in other systems will be developed, and the results of incentive evaluation will be used as an important basis for project coordination and additional support, as well as to improve efficiency in the use of scientific research resources by allocating them to outstanding personnel and teams.

The reform also calls for the establishment of a mechanism whereby researchers will be evaluated solely on the basis of their abilities, not their titles, by actively incorporating peer evaluation, and for bonuses and other incentives to be paid based on an evaluation of results (contribution, influence, and quality) of so-called “representative works,” rather than on the “four only” standard.

5.5.5 Scientific research credit building

Although reforms are underway in a wide range of areas, they all have a common purpose: to reduce the burden on researchers and expand their independence. Along with more “freedom,” what is being sought is “autonomy,” and scientific credit is being emphasized more than ever. Acts that damage scientific credit can occur at three main stages: application for a research topic, implementation of scientific research, and commercialization of results. At the stage of application, discreditable acts mainly involve illegally winning scientific research projects for oneself or others through abuse of research topic management authority, specifically, fraudulently obtaining scientific funds by duplicating research topics or making false applications (on the part of the applicant), or assisting in winning projects by way of divulging information in advance (on the part of the experts). These acts may constitute crimes such as corruption and giving or accepting bribes. At the stage of implementation of scientific research, discreditable acts mainly involve violations of fund management regulations; abuse of the right to self-manage funds; project subcontracting; “false contracts“; “false accounting“; and “false receipts” for procurement, business travel, and so on. These acts often constitute crimes such as corruption and misappropriation of public funds. At the stage of commercialization of results, discreditable acts mainly involve mismanagement of funds and abuse of corporate managerial authority. In situations where intellectual property rights are unclear, and the attributes or shares of the subcontractor company are unclear, this frequently results in crimes such as corruption, abuse of authority, and misappropriation of funds.

Scientific credit building will include two main aspects. First, the number of inspections of the project progress will be reduced as much as possible, and random checks will be conducted instead. Since these checks do not require advance preparation, slight discrepancies will not be considered as problems, and as long as the minimum guidelines are followed, the project will pass the inspection. Second, in the event of a rejection despite evaluation according to such lax criteria, or in the event that misconduct such as plagiarism and forgery, as described above, or bribery and solicitation are discovered, a lifelong responsibility system will be implemented, and a permanent record will be kept in a database of discreditable acts in scientific research.

These reforms have several goals. The first goal is to reduce waste of funds. The amount of funds for various programs has been increasing year by year, and researchers are provided with a free research environment to pursue "scientific and technological innovation." However, even the slightest diversion can lead to waste of funds, resulting in a situation where funds are not allocated to necessary research. Therefore, the government is taking steps to thoroughly combat misconduct and corruption. The next goal is to improve the quality of research. Although China ranks first in the world for the number of scientific papers published, its reputation is relatively low, probably due to quality issues. Many researchers chose the path of publishing more papers in prominent international journals to increase their numbers and develop a "good image." In a system where evaluation was based on the number of papers, this is a choice that cannot be criticized. As a result of this practice, there were many cases of papers with almost identical content but different titles and layouts, and of researchers winning multiple projects with similar research topics. Although these practices was criticized, the system for detecting fraud was ineffective, and the review process and associated penalties were relatively lax. The current reform will make maximum use of ICT technologies such as big data to improve the efficiency of supervision and inspections. Research institutions will manage the use of research funds in real time and conduct dynamic monitoring through warning reminders to ensure the rational use and reliability of research funds. The purpose of the database of discreditable acts in scientific research is to enhance the overall quality of research by identifying misconduct and guiding researchers in the direction of "fewer but better" papers. The final goal is to punish individuals to make an example for others. Researchers who are found to have committed scientific misconduct not only will be subject to public criticism via the Ministry of Science and Technology website and will not be able to apply for funding projects for several years (3-7 years) but will have to take lifelong responsibility, effectively ending their research career. The decision to make this entire process public is a statement of the central government's intention to seriously strengthen the credit system for scientific research and could be considered a warning to researchers.

5.5.6 Diversification of encouragement methods

The funds available for incentives have been expanded through the reform of indirect costs. In addition, profits generated from the conversion of scientific and technological achievements can also be distributed, and researchers are allowed to receive the equivalent of their profits in cash or stock. In the past, the achievements of researchers from their R&D efforts often belonged to their institutions, and the researchers rarely received a share of the profits generated by their achievements. However, this system began to be reformed in 2014. At the time, Li Keqiang said, "Under such a mechanism, it is natural that researchers are not motivated and passionate, and the number of researchers who can devote themselves to research is decreasing day by day. Reform is inevitable if we are to achieve original research and significant scientific and technological achievements." In September 2014, the Ministry of Finance, the Ministry of Science and Technology, and the China National Intellectual Property Administration issued the "Notice on deepening the reform pilot project on the use, treatment, and management of profits from science and technology achievements at national research institutions." The notice stated that profits from scientific research achievements would not be paid into the national treasury but would be incorporated into the budget of scientific research institutions. In the following year, the "Law on Promoting the Conversion of Scientific and Technological Achievements" was amended to ① allow the voluntary transfer, licensing, and investment of research achievements, and promote the capitalization and industrialization of science and technology achievements through corporate or individual stock investment and capital injection; ② granting universities and research institutions the right to use, dispose of, and profit from research achievements, and awarding more than 50% of the profits from the conversion of achievements to researchers who made significant contributions; and ③handling investment through conversion of research achievements (e.g., patents) into stock prices in accordance with the provisions for conversion of research achievements, so that the principal researchers own 50% of the investment amount resulting from the conversion of research achievements. The amendment of the Law on Promoting the Conversion of Scientific and Technological Achievements made it possible for researchers to receive part of the profits from their achievements. Another notable policy document was the 2018 "Decision on special taxation measures related to incentives for researchers to promote the commercialization of research achievements by universities and other institutions." This decision stipulated that researchers and engineers of nonprofit research organizations, universities, and other institutions who have obtained patents, software, new biopharmaceuticals, and so on, through their professional R&D and have received cash incentives within three years after the transfer or licensing of those achievements can deduct half of the cash incentive amount when calculating their income tax for the current month. The decision also established several policies to support the distribution of incentives to researchers and engineers. The "Notice of the State Council on measures to optimize scientific research management and enhance scientific research performance" was issued in the same fiscal year. The notice states that "researchers will be granted the right of ownership or long-term use of scientific and technological achievements" and that "advanced integration mechanisms between industry, academia and research will be developed that link scientific and technological achievements, and an Alliance for Innovation in Industry, Technology and Research[360] involving research institutions, enterprises, and other relevant parties will be established to implement related policies. Support will be provided for researchers from higher education institutions and scientific research institutions to visit state-owned or private enterprises to concurrently work on R&D and the practical application of achievements. Stock incentives for the practical application of scientific and technological achievements by scientific researchers in higher education institutions, scientific research institutions, and state-owned enterprises will be strengthened. Cash and incentives for the practical application of scientific and technological achievements made by scientific researchers in the course of their duties will be incorporated into the total amount of performance-based pay of such institutions for the current year, and the total amount will not be restricted."

Regions are focusing on the distribution of revenue to researchers, adopting their own rules based on these regulations. The city of Beijing enacted the "Beijing Municipal Ordinance on the Promotion of Science and Technology Achievement Conversion," which raised "the rate of distribution of profits from the conversion of achievements from 50% to 70% as stipulated by law." Meanwhile, Liaoning Province enacted the "Liaoning Province Technology Conversion System Construction Implementation Plan," which states that "at least 70% of profits from the conversion of achievements will be distributed to R&D teams and researchers who have contributed to the conversion."

[360] Original term: 产业技术创新联盟. This is an organization in which enterprises, universities, and scientific research institutions form an alliance based on a contractual agreement, utilize their strengths, and share benefits and risks in order to improve their industrial and technological innovation capabilities based on the development needs of enterprises and mutual common interests.

5.6 Comparison with basic funding systems in the U.S. and Europe: Focusing on major factors in funding

Funding systems in each country encompass a variety of mechanisms depending on the approach to and history of research funding. Broadly speaking, these can be divided into mechanisms that provide small subsidies to a wide range of basic research projects and mechanisms that support large-scale, concentrated applied and experimental development research projects. There can also be further differences, such as whether these categories themselves are funded by the institution's main grant or by external competitive funds. In this section, we will examine the specific methods used to provide financial support to researchers in realizing their ideas in the funding systems of Japan, the U.S., Europe, and China from the perspective of basic research promotion.

Therefore, we will compare the ways in which researchers apply for the research funds necessary to conduct steady, routine research based on their free ideas, as well as the ways in which their applications are reviewed and evaluated, rather than the ways in which large-scale projects are applied for, reviewed, and evaluated. This examination includes the U.S. National Institutes of Health (NIH), the French National Research Agency (ANR: Agence nationale de Recherche), and the NSFC as the main funding institutions, and attempts to compare the application rules for the NIH R01, the ANR PRC (Projets de Recherche Collaborative), and the NSFC General Projects. The systems of each funding institution are quite complex, and the details of their mechanisms have different nuances, so this may not necessarily be an appropriate comparison. However, since we do not believe that such a comparison has ever been made before, we hope that this will be a precursor to further analysis in the future.

The comparison criteria are whether researchers can routinely have free ideas; build research projects based on those ideas; assemble and budget for the necessary team members, research partners, facilities, equipment, materials, travel expenses, and so on; and execute the research in a prompt and timely manner, without being overwhelmed by administrative tasks. To that end, the evaluation criteria include the timing and cycle of research funding applications, the involvement of affiliated institutions in the application (support or restriction), the composition of team members, the review system and review content, and administrative matters such as ex-post reporting and inspections. The most important perspective for comparison is whether the resulting systems allow interactions among researchers that stimulate scientific research.

(1) Clerical work related to applications

First of all, the presence or absence of restrictions on application, including the applicant's nationality and affiliation, is an extremely important factor for researchers as the entry point of the application process. In the case of the NIH, it is possible to "apply for research related to the establishment and maintenance of a single laboratory," as a system that only covers cooperation among multiple institutions would create a barrier for entry for researchers. Meanwhile, in the case of China, this restriction does not appear to exist. In the case of Japan, grants and subsidies associated with an institution only support studies by researchers at that institution, whether it is a university or a research institute. From a financial perspective, it is logically impossible for researchers of that institution alone to receive a large amount of external government funding, as that would overlap with expenditures under management expense grants. Therefore, the principle is to seek the participation of multiple institutions, although this needlessly restricts researchers' ideas.

In the case of the U.S. NIH, nationality clauses such as being a U.S. citizen or a U.S.-born foreigner are found, whereas in France and China, nationality clauses are not always clear. The NIH has no specific regulations on eligibility for participation, whereas the ANR has a limit on the number of PIs and China has a partial recommendation system in addition to this limit. Although the direct impact of adopting the recommendation system itself cannot be determined without a more detailed look at its operation, its presence does suggest a strong involvement of organizations.

In the case of U.S. universities, the university's Sponsored Program Administration Office (SPAO) is often in place to assist with everything from application to fund management[361]. In the case of China, the function of specialized agencies as intermediary organizations is considered to fall under this category, although further investigation is required. In France and China alike, the use of electronic systems has progressed considerably in recent years, and the paperwork involved in applications in particular has been simplified.

(2) Timing and number of applications and reapplications

In the case of the NIH R01, applications are submitted three times a year. The ANR operates on an annual cycle, beginning with open recruitment in July and ending in July of the following year. China has both centralized and non-centralized selection, and centralized selection is prevalent, with a deadline of March 20 each year. From researchers' point of view, more frequent application windows, as in the case of the NIH, is more compatible with researchers' cycle of ideas. A timing or frequency of once a year is hardly in line with researcher's behavioral patterns. However, it is commendable that in the reform of China's Key Basic Research Projects, a mechanism has been established to allow applications at any time.

As for the possibility of reapplication, since the NIH allows up to three applications under the same title and the ANR does not accept applications with repeated titles, although this is not always explicitly stated, reapplication appears unlikely. Under the NSFC system, a third application will not be accepted if applications have been rejected for two consecutive years. Even if the title is the same, the content of the application may differ from that of the initial application due to the addition of data from subsequent preparatory studies or refinement of the application content through scientific communication with the program officers, and so on. In fact, in the case of the NIH, it has been observed that the more times an application is submitted, the more likely it is to be accepted.

In addition, a system such as that of the NIH, which allows the submission of additional data until just before the review is conducted, is quite in line with the realities of researchers' activities. In this regard, the ANR has a system that allows modification in accordance with the progress of the research in the secondary application, whereas the NSFC does not allow any modification other than cancellation.

(3) Research start date

The time between application and the start of research should be as short as possible. In other words, the earlier the research funds are actually available, the better. For the NIH, the time appears to be three months after review and about six months from application. For the ANR, research usually begins on October 1 of each year, or one year and three months from application in July of the previous year. In the case of the NSFC (centralized selection), research funds are awarded approximately five months after the application is received. Considering the number of applications

[361] Suga Hiroaki, "American Scientists in Friendly Competition: A Complete Picture of U.S. Academia and Competitive Fund Application and Review," October 4, 2004, Kyoritsu Shuppan, p. 57.

per year mentioned above, the NIH system is quite agile, allowing researchers to apply three times a year and to start research only three months thereafter.

(4) Research period

The research period is extremely important, as it is the period during which the research can be sustainably continued once funded. In the case of the NIH, the maximum limit is five years. ANR grants are not limited but generally span three to four years. In contrast, NSFC grants are usually as short as one or two years. This is a significant factor in the tendency to seek short-term results and is a major constraint on the ideas and activities of researchers.

(5) Research funds

For the U.S. NIH, funding is modular, with a maximum of 10 modules requested at USD 25,000 per module. Additional funding is required for request exceeding that amount. For the ANR, the minimum funding is EUR 15,000. For public research institutions, projects can be funded 100%, whereas for private enterprises, there is a limit of up to 45% of the required funding, for example, for basic research. The NSFC uses two methods: a flat-rate system (with a maximum limit) and a cost-reimbursement system. Basically, the latter system requires the prior submission of budget sheets only for direct costs, whereas indirect costs can be allocated freely by the host institution (see section 5.5 for recent reforms).

As for the allocation of research funds to personnel costs, in the U.S., 12 months' salary is rarely provided, and allocation is limited to 3 months for researchers (applicants). However, applicants may request the shortfall if they only receive 50% of their salary from the university. Funds can be allocated to personnel costs for doctoral students, administrative secretaries, and so on. In the case of the ANR, allocation of funding for personnel costs is not allowed for full-time employees of public research institutions but is allowed for research assistants. In the case of China, allocation of funds is relatively free. Personnel costs, which are called "labor costs," are expert advisory fees can be included in direct funding with no restrictions on the amount. In the case of the NIH, the PI has the right to decide on salary payment standards. In the case of the NSFC, the host institution makes the decision with the NSFC's approval.

The method of payment of research funds is unknown for the U.S., whereas for France it is in installments (three installments of 30% and one installment of 10% for three years), and for China, it is a lump-sum payment (the budget must be reorganized and submitted along with the determined payment amount within 20 days after the project is approved).

The question of whether researchers can receive financial support from more than one funding institution and whether such funds can be mixed is extremely important. The U.S. NIH regulations do not appear to be particularly restrictive in this regard. For the ANR, co-funding is available with eight institutions, including the Defense Innovation Agency, and especially with the Ministry of Solidarity and Health, which allows for collaboration in trans-relational research. The NSFC states that funding for the same research topic cannot be received from another institution.

(6) Changes in research plans, etc.

Research cannot always proceed as planned, and in principle, it is very important to be able to change plans without restrictions. In the case of the NIH, researchers are basically free to change their plans and budgets, although certain changes require prior approval by the NIH. The ANR is mostly the same, with certain prior approval requirements.

Under the NSFC, researchers apply to the host institution, and the host institution receives permission from the NSFC.

(7) Indirect costs

Indirect costs are a financial measure that has not been emphasized in France in the past. In recent years, however, this system has received a great deal of attention, accounting for up to 40% of the costs being covered (there are several beneficiaries, including the host institution and the organizational unit to which the researcher belongs). In the U.S., it is well known that each university and host institution has a specific indirect cost rate and that the host institution will incur substantial indirect costs once the proposal application is accepted. In the case of China, as mentioned above, various reforms have been implemented, such as changing the percentage of indirect costs based on the characteristics of the research (e.g., 30% for research funding up to CNY 5 million) and, recently, abolishing the pre-determined allocation between direct and indirect costs.

(8) Details of review, including review methods

The method used to review applications is also extremely important as an academic exchange that is directly related to the development of the applying researcher. The NIH, ANR, and NSFC all review applications in multiple steps. In each step, an expert review is conducted in a certain manner, ranging from document-only review by outside experts to committee review. There is little difference in the format in which these steps are taken.

We are actually not sure how the experts involved in the review process are selected. In the case of the NSFC at least, it is unclear whether foreigners are involved in the review process. In the case of the U.S., there are no clear rules, but the focus is on the expertise involved in the review. Meanwhile, in the case of France, data show that up to 60% of the experts are foreigners (although this figure would be considerably lower if experts from other European countries were not considered foreign). The participation of foreign reviewers in itself is a delicate matter. The process of the so-called peer review method presents the applicant's own ideas without protection and may be difficult to engage in without a certain level of mutual trust among researchers. Therefore, it is not clear whether China itself will adopt such a method. In any case, the question is not whether foreigners are involved, but whether a critical mass (a sufficient number) of peers covering sufficient expertise in a certain field or subject matter participate in the review in a timely manner and whether there is creative communication between the reviewers, the program officers, and the applicant. In other words, it is crucial for program officers to exchange scientific information with the applicant during the review process, based on the opinions of the experts involved in the review, working to draw out the applicant's scientific ideas to refine the content of the application. This is an extremely important aspect of the role of funding agencies in pushing the frontiers of science and is especially critical in the promotion of basic research. The NIH and other U.S. systems are elaborately designed to achieve this goal and have a long track record of doing so. In contrast, in the case of the ANR, we know that critiques based on the review are sent to the researcher prior to the final review meeting, but studies to date have not been able to specifically investigate, analyze, and evaluate the activities at this stage within the system of each institution. As for the NSFC system, it is unclear how the process is implemented, at least based on the publicly available information.

(9) Interim reports and final reports

One mission of researchers is to report their research results in the form of a final paper. This serves to open up new frontiers of science and create a bridge for many researchers to take the next step. Therefore, the task of presenting the results of funded research is, in a sense, an obligation that comes with the use of public funds. However, that obligation is essentially only owed by the funding agency to congress, and the burden on researchers should be minimized. In this sense, there is no doubt that this task should be as light as possible.

In any case, the requirement for annual reporting is the same for any system of any funding institution. However, in the case of the U.S., the above-mentioned SPAO provides significant support for the preparation of financial reports, helping to reduce the burden on researchers. Furthermore, from the perspective of researchers, it is of great interest whether or not research results are evaluated. However, it has been difficult to compare and gauge how this evaluation is conducted through detailed research and analysis.

6 Advantages and Challenges of the Research System from the Perspective of Chinese Researchers

The previous chapters introduced various reforms enacted by the Chinese government in recent years and reviewed the current situation and challenges, particularly with regard to basic research promotion and scientific research management reform. Reform trends involving the NSFC, the main funding agency of the Chinese government, have been introduced as well.

In this chapter, we will consider the effects of these reforms, further challenges that lie ahead, and the problems peculiar to China that they entail, to add new elements to our perspective on China's future science and technology policy.

6.1 Opinions on research system reform from the Chinese scientific community

Information on analyses and evaluations of the various Chinese government reforms mentioned above is difficult to obtain. Nevertheless, valuable information can be gleaned from scientists' research publications and some media reports.

6.1.1 Positioning of basic research

Basic research in China has already been addressed several times, and the points made above will not be repeated here. The bottom line is that basic research in China is essentially "applied basic research."

As relevant documents were being formulated, between January 2018 ("Opinions of the State Council on the overall strengthening of basic scientific research"), and January 2020, an extremely noteworthy paper was published by Chinese scientists.

This ambitious paper, entitled "Few opinions on Building the Basic Research Power of China[362]," was published by Tao Cheng et al. of the CAS Bureau of Development and Planning. Tao et al. recognize that major countries such as Japan, the U.S., and European countries have achieved their current economic development as innovation powers owing to their long-standing policy of emphasizing basic research and that China should follow their example. However, "although, in principle, basic research pursues fundamental understanding, its role in supporting the goal-oriented nature of applied development is becoming more prominent," as exemplified by "translational research" and "the 'nationalization' and 'corporatization' characteristics of scientific innovation activities" are becoming more pronounced. Drawing on examples of these trends from Europe and the U.S., Tao et al. argue that for China, too,

362 "关于我国建设基础科学研究强国的若干思考"、陶诚（中国科学院发展规划局）、张志强（中国科学院成都文献情报中心科学计量与科技评价研究中心）、陈云伟（中国科学院大学经济与管理学院图书情报与档案管理系）、世界科技研究与发展、WORLD SCI TECH Ｒ＆Ｄ、第41卷、2019年2月、第1期、1-15页

"government-led directed basic research is a strategic mission for the country." They emphasize that China has not invested much in basic research in the past and stress the need for stable, long-term investment in the future. Tao et al. use the terms "free research" and "free exploratory research" throughout the paper, referring to the focused investment in basic research in Japan, the U.S., and Europe but ultimately state that the government's priority should be directed basic research.

Although each word of a long paper contains a great deal of meaning, as usual in this type of writing, there is considerable repetition, and the meaning is concentrated in surprisingly few places. Thus, to quote its key passages, the paper reads as follows.

The purpose of instituting a policy system that supports the development of basic research is, on the one hand, "to satisfy the need for 'free exploration'" and, on the other hand, "to focus energy on quickly and effectively solving important basic science problems related to the strategic demands of national development." The first step is to optimize the system of key areas for basic scientific research; meet the country's strategic needs in information science, life science, and materials research; and realize application-oriented directed basic research achievements. The second step is to strengthen the construction of a systematically organized framework for the training and allocation of excellent talent in basic research and to basically complete a system for the exchange of science and technology talent and international science and technology collaboration programs that will allow China to take the lead and utilize its resources. The third step is to properly balance funding for top-down competitive support programs designed at the national level; stable support for institutional budget funding for the independent allocation of strategic science and technology areas by national strategic science and technology institutions; and funding for free, exploratory, high-risk basic research projects supported by the Natural Science Foundation, so as to develop both competing national and institutional directed basic research and free, exploratory, high-risk basic research by individuals and research teams. The fourth step is to support excellent innovation institutions in specialized fields that are oriented toward research on a series of new types of important scientific problems and to form a national innovation system for basic scientific research that can continuously address challenging and difficult problems. The third point is particularly noteworthy; it expresses the idea of allowing the top-down design of national and scientific research institutions to compete and develop together with free exploratory research by individuals and teams.

Although this paper is a proposal from scientists, its contents do reflect the policy of the CPC Central Committee and the measures to promote basic research that were subsequently formulated in the 14th Five-Year Plan for National Science, Technology, and Innovation. This paper displays a spirit of thorough adherence to the major premise of the CPC leadership, that is, the idea that by positioning even basic research in the arena of "goals" and "applications," research can be designed by the State and lead to achievements. In short, based on the results of policies emphasizing basic research in Japan, the U.S., and Europe and taking into consideration the current state of basic research, this paper encourages "free exploratory research" but ultimately reveals an excessive emphasis on "directed basic research" to meet national socioeconomic needs. The fact that the contents of such a paper have risen to the level of policy documents, thoroughly implemented by the secretary of the Communist Party, and embodied in the resource allocation policy of funding agencies does indeed indicate that the direction of "free" and "exploratory" research is being pursued. However, in the field, there are still concerns that this policy may exclude researchers who conduct so-called pure basic research. Tao et al. express an awareness of this issue at the end of the paper. This is inferred from the following passage: "This consists of long-term and stable government support for basic research, reasonable guidance and setting of expected goals, and relaxed review of performance and effectiveness, as well as a framework to broaden and deepen basic research in the long term through a kind of social contract based on the science and technology system between the government and scientists. On the contrary, excessive government ‘guidance’ in the selection of indicators and topics for basic research can lead to dispersion and constrain the progress of original and innovative basic research. Avoiding excessive government ‘guidance’ does not mean letting basic research be an absolutely free model driven entirely by interest but rather achieving an appropriate balance between important directed basic research guided by government initiative and national goals, and cutting-edge basic research driven by scientists’ independent decision-making and free exploration.” This is a very significant “guidance” policy. However, the phrase “does not mean letting basic research be an absolutely free model driven entirely by interest” may be seen as limiting the freedom of researcher’s ideas, drawing on the CPC’s basic approach to “freedom” as something that is granted under certain social restrictions. If so, that would be incompatible with the basic idea of a democratic state. Unless measures are taken to promote basic research centered on independent decision-making and free exploration by scientists, original research and innovation will not occur.

Finally, the paper by Tao et al. concludes: “In the process of building a powerful country in science and technology in the next 30 years, China should actively lay out strategic basic science research work in relevant fields to meet the needs of certain national goals (...) accurately discern the development trends of global science and technology innovation, steadily promote basic research, scientifically plan the process of building a powerful country in science and technology, and support the construction of a modernized powerful country.” We must call into question the idea that anything can be planned scientifically.

6.1.2 Use of indirect costs

In the September 13, 2021 edition of *Science and Technology Daily*, A Ruhan, Associate Research Fellow of the CAS Institutes of Science and Development, offers suggestions to further advance the “indirect cost reform” promoted by the government, taking into account the issues observed even after the reform was implemented[363]. The “Opinions of the Central Office of the State Council on the reform and improvement of fund management for scientific research funded by the central government[364],” issued on August 13, 2021, reformed indirect costs, clarified the basis of calculation, and allowed incentives for researchers to be paid as indirect costs. Although she

363 “Continuous Promotion of Establishment Fund Reform: Systematically Solving the Problem of Incentives for Researchers,” A Ruhan (Fellow of the Chinese Academy of Sciences Institutes of Science and Development), Science Topic No. 182, November 11, 2021, Science Topics, Science Portal China, JST, https://spc.jst.go.jp/hottopics/2112/r2112_a.html (accessed December 12, 2021)

364 Economic Office, Embassy of Japan in China, China Economic Weekly Report (August 12-18, 2021) https://www.hqts.jp/news/%E5%9C%A8%E4%B8%AD%E5%9B%BD%E6%97%A5%E6%9C%AC%E5%A4%A7%E4%BD%BF%E9%A4%A8%E7%B5%8C%E6%B8%88%E9%83%A8-%E4%B8%AD%E5%9B%BD%E7%B5%8C%E6%B8%88%E9%80%B1%E5%A0%B1%EF%BC%882021-8-12%EF%BD%9E2021-8-18%EF%BC%89/ (accessed December 12, 2021). According to this report, on August 13, 2021, the Central Office of the State Council issued the “Opinions on the reform and improvement of fund management for scientific research funded by the central government.” The purpose of these opinions is to help researchers produce higher quality science and technology achievements and realize independence and self-reliance in advanced science and technology by further expanding the autonomy of research project funding management, increasing incentives for scientific researchers, and reducing the burden on researchers, through 25 measures in 7 areas. The 14th Five-Year Plan introduced policies such as reforming the system of public funding for scientific research, granting scientific researchers greater rights to use funds, and improving the system to manage the results of inventions made during the course of researchers’ duties. An important speech by Central Secretary Xi at a joint Congress of Academicians (in May) stressed the importance of reducing the burden on scientific research personnel. In July, the State Council decided to “further reform and improve fund management for scientific research funded by the central government” and “give scientific research personnel more autonomy in managing funds.” These opinions are considered the embodiment of the above policies.

commends these initiatives, A Ruhan believes that further reforms are needed. In 2011, the Ministry of Finance and the Ministry of Science and Technology jointly issued the “Notice on adjustment of provisions for the National Science and Technology Plan and measures for the management of special scientific research funds for industries of public interest,” which introduced the concept of indirect costs for the first time. These measure allow project costs to be divided into direct and indirect costs, and allow funds to be allocated to some indirect costs that are not included in direct costs, particularly “administrative costs” such as usage fees for equipment and facilities and utility costs incurred by the research institution tasked with implementing the projects. Since that time, the proportion of indirect costs has been progressively increased. Indirect costs began to include monetary incentives for researchers, and their proportion progressively rose. Finally, in 2016, the CPC Central Committee and the Central Office of the State Council issued the “Opinions of the Central Office of the State Council on the reform and improvement of fund management for scientific research funded by the central government,” which removed the limit on the ratio of incentive spending to indirect costs. The 2018 “Notice of the State Council on measures to optimize scientific research management and increase scientific research incentives” further increased the proportion of indirect costs themselves (e.g., indirect costs cannot exceed 30% for projects up to CNY 5 million) based on the requirement to “experiment with expanding autonomy in the use of scientific research funds.” In general, two reforms have been implemented: the proportion of indirect costs has been increased and the proportion of monetary incentives paid to researchers from indirect costs has been increased as well. From the perspective of host institutions, which traditionally did not have a clearly designated source of funds for administrative costs and researcher incentive spending, these reforms have been very effective.

However, according to A Ruhan, “Despite the success of the reforms, there are still many problems with the current indirect costs.” A argues that the details of indirect costs are not sufficiently clear and lack a true cost accounting and that the evaluation of researcher incentives and indirect costs are too strongly related. With regard to the former point, A states that it will be necessary to have a clear accounting of overall expenses from the side of the scientific research organization. This requires that truthful and accurate accounting of incurred expenses be made. With regard to incentive spending, A sees a problem in relating incentives for researchers to the situation in which the host institution is undertaking the project, questioning whether incentive pay should be funded from indirect costs in relation to the overall compensation system for researchers.

A generalizes this as an issue common to all countries that provide public funding for science and technology, including China, noting that such matters have been the subject of debate since 1945, when Vannevar Bush raised the issue of the “rationale for government funding of science” in “Science, the Endless Frontier[365].” However, we question whether that is really the case. As mentioned above, although China has abandoned the planned economy approach and is pursuing a socialist market economy, it is still unable to escape the major framework of State control and is still aiming for “scientific project fund management” and “standardization reform” in its science management approach. Bush’s proposals for “transparent cost accounting on the part of scientific research institutions,” “identification of real

365 Science The Endless Frontier, A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945 https://www.nsf.gov/od/lpa/nsf50/vbush1945.htm (accessed December 12, 2021). The author’s conclusion that the freedom of the research implementing agency to conduct research should be respected, and internal control should be entrusted to the same agency, should not be overlooked. “Therefore I recommend that a new agency for these purposes be established. Such an agency should be composed of persons of broad interest and experience, having an understanding of the peculiarities of scientific research and scientific education. It should have stability of funds so that long-range programs may be undertaken. It should recognize that freedom of inquiry must be preserved and should leave internal control of policy, personnel, and the method and scope of research to the institutions in which it is carried on. It should be fully responsible to the President and through him to the Congress for its program.”

needs for resources in scientific research activities," and "calculation of indirect cost ratios on the part of research institutions using a bottom-up approach" will set the course for further reform. If China respects the autonomy of scientific research institutions, that is, their management strategies, in the first place, it should also leave the calculation of indirect costs to them when they are entrusted with a project. In the U.S., indirect costs are determined by the universities or other institutions themselves. In France, the government takes the lead in guiding the rate of indirect costs when funding agencies are commissioned. As noted by A, using monetary incentives as an example, having the host institution of the research project determine the basis of calculation with a bottom-up approach is not necessarily an appropriate way to increase overall incentives for research institutions and researchers.

However, Bush is probably correct in suggesting that with respect to incentive spending on researchers, "scientific research fund management should be conducted on a more scientific basis by steadily promoting reform of reward programs for researchers, establishing a dynamic and rational compensation adjustment system, and weakening the relationship between staff compensation and projects." In short, the argument is made that incentive spending on researchers should not necessarily be positioned as an expenditure from indirect costs but should be positioned and financed within the original reward program.

6.1.3 Balancing free allocation of scientific research funds and strict supervision and management

In the September 27, 2021, issue of *Science and Technology Daily*, Professor Di Xiaohua of the Nanjing University School of Law discusses how free allocation of research funds and strict supervision and management are balanced in various reforms[366]. This paper gives us a glimpse into the central government's views on the use of research funds.

While he appreciates that the reforms mentioned above have "loosened the purse strings" on research funding and given researchers more freedom in managing research project funds, Di states that huge amounts of research funding are now being fought over and eroded by researchers[367]. He argues that this needs to be avoided and that the situation calls for balancing "the relationship between the free allocation of scientific research funds and strict supervision and management." Let us look at the problems Di is pointing out and the improvements he is calling for.

Corruption in the management of research funds is a serious issue, and a rigorous management system has been established through measures such as the "Provisional regulations on strict recording of discreditable acts related to the National Science and Technology Plan (special projects, funds, etc.)" issued on March 25, 2016, as mentioned in Section 7.4. Recently, the Fifth Plenary Session of the 19th CPC Central Committee for Discipline Inspection has designated corruption eradication as a priority for 2021, and reform efforts are underway. The issue raised here is how to manage the increasing amount of scientific research funds and how to allocate the funds to legitimate use without discouraging researchers. In other words, although "enhanced anti-corruption" and the accompanying scientific research funding management measures have been effective, the complexity of expense reimbursement

366 "Accelerating the Process of Legalization of the Management of Scientific Research Funds: Balancing Free Allocation and Strict Supervision and Management," Di Xiaohua, Professor, Nanjing University School of Law, November 16, 2021, Science and Technology Topic No. 182, JST Science Portal China, https://spc.jst.go.jp/hottopics/2112/r2112_di.html (accessed December 13, 2021)

367 Scientific research funds are described as highly coveted (the original expression literally translates to "the flesh of the monk Tang Seng," which is said to have the ability to make people immortal).

and the cumbersome procedures required have discouraged researchers from being proactive in their scientific research activities. At the same time, the 2016 "Opinions of the Central Office of the State Council on the reform and improvement of fund management for scientific research funded by the central government" jointly issued by the CPC Central Committee and the State Council introduced the so-called reform to "delegate power, streamline administration, and optimize government services[368]." This reform led to progress in corruption control in scientific research management while at the same time empowering researchers to create innovation. However, the opinions clearly expressed that corruption control is still a long-term and difficult task.

Corruption risks in the management of scientific research funds include the following: at the application stage, illegally winning projects through abuse of research topic management authority and fraudulently obtaining research funds through false applications, which may lead to corruption and giving or accepting bribes; at the stage of implementation of scientific research, violations of fund management regulations, abuse of the right to self-manage funds, project subcontracting, false procurement contracts, false accounting, false receipts, corruption, and misappropriation of public funds; and at the stage of commercialization of results, mismanagement of funds and abuse of corporate managerial authority, which may lead to corruption, abuse of authority, and misappropriation of funds, such as selection of companies with unclear intellectual property and reasons for selection.

In this way, Di Xiaohua newly points out the "corruption risk" that comes with stricter research management, which is different from the so-called "credit issues" and "corruption issues" that have been discussed and addressed in the past and argues that measures are now necessary to address this risk. What is needed, then, is "a balance between the right to conduct free scientific research and the power to manage funds." Here, Di Xiaohua first raises three issues.

The first is the conflict between the guarantee of freedom and supervision or restriction. While Di Xiaohua maintains that freedom of scientific research is important, he argues that there is no such thing as "absolute freedom," and cost allocation freedom should be consistent with fund management norms. It feels somewhat unnatural to position compliance with norms in opposition to absolute freedom, as Di is doing here. The second issue is the conflict between administrative management and scientific research services. In other words, the host institution is both the department that conducts research management and the department that implements scientific research autonomy, as well as the agency that provides science and technology research services. In reality, however, labor shortages have limited service institutions' role, forcing them to opt for "strict management." The third issue is the imbalance between scientific research guarantees and scientific research incentives. The government guarantees researchers the freedom to conduct scientific research and provides them with funding and incentives. However, in this process, researchers such as faculty at higher education institutions have the triple duty of teaching, research, and social service, and their current salaries as faculty do not fully take into account rewards for scientific research. In other words, it is necessary to increase the distribution of incentives in research topics.

After pointing out these current problems, Di Xiaohua offers the following suggestions. First, he states that it is necessary to further strengthen the autonomy of researchers and the independence of host institutions, develop legal services for scientific research, strengthen rule of law publicity in research topic applications, and subdivide risk warnings in research topic management to cultivate researchers' knowledge of the rule of law and raise their awareness

368 The reform to "delegate power, streamline administration, and optimize government services" includes "simplified government and delegation" (streamlining of administration and delegation of authority), "integrated administration and management" (combining both strengthening of supervision and management and delegation of authority), and "optimized services" (improving the level of services).

of corruption risk. Second, the system of services for scientific research should be enhanced so that researchers can concentrate on talent development and research. Therefore, it is important to improve and develop service frameworks by establishing a specialized support system for budgeting, to improve and develop cost-accounting and financial system services for research topics by reforming the method of hiring temporary financial assistants and training specialized financial personnel, and to develop a framework for the practical application of scientific research achievements. In particular, the practical application of scientific research achievements requires the establishment of bases for this purpose at universities, specialized institutions for the same purpose at higher education institutions directly under the State Council or provinces, and institutions pursuing the same goal at the national level.

In addition, Di offers the following suggestions. First, to protect the rights of researchers to conduct scientific research, it is necessary to establish a system to guarantee these rights, based on remuneration for scientific research and supported by scientific research incentives. To that end, in the case of university faculty, remuneration for scientific research should be clearly defined, and indirect costs should be calculated and used as incentive pay for professional researchers and educators, with ratios for subjects in the humanities, sciences, and engineering, and for scientific research professional and educators, respectively. Aside from this incentive pay, there should be a certain amount of material and moral encouragement for outstanding performance. However, Di states that the chaos caused by overlapping or excessively numerous incentives should be avoided. Finally, the allocation of rights in the practical application of achievements should be clarified.

Overall, the above suggestions by Professor Di Xiaohua are based on the question of how to reconcile the CPC Central Committee’s stance of guaranteeing the freedom of scientific research with the current situation where researchers are required to implement management procedures that seem excessively strict, to the extent that researchers may view these procedures as limiting their freedom to conduct research while also taking into account the ethical issues involved in the misuse of research funds. Addressing research misconduct is a constant in major countries such as Japan, the U.S., and European countries. This problem is difficult to overcome completely as researchers with a wide variety of ideas are trained one after another from generation to generation. In light of this problem, the relevant institutions in each country should continuously review their systems to ensure thorough awareness and action. Unfortunately, addressing research misconduct is a common challenge found in all countries. However, the solution pursued by the central government should not be to become permanently involved in the field of scientific research and adopt a managerial approach, as mentioned by Professor Di Xiaohua.

Since his analysis is probably based to some extent on feedback from the field of scientific research in China, it is expected that the CPC Central Committee, the State Council, the Ministry of Science and Technology, the Ministry of Education, and other institutions will eventually give it due consideration. Hopefully, the further tightening of management in itself will not result in a reduction of incentives for researchers who are tasked with implementing scientific research.

6.1.4 Personnel and other management authorities

First, let us look at personnel management authority. The system and actual situation of personnel management authority are difficult to ascertain. However, we will introduce the results of the “University Personnel Dispute

Research Questionnaire (2014)[369]" on personnel management authority conducted in 2014. Since the questionnaire is somewhat outdated, the results can be seen as reflecting the actual situation before the reforms introduced under the Xi Jinping administration.

This survey is mainly concerned with how and why personnel-related problems occur, and how they can be remedied.

Regarding the circumstances and causes of the problems, 52% of the respondents said that administrative power over personnel management authority has a great influence, 49% said that there are problems in setting up posts, 33% said that open recruitment is only a formality after job offers have already been made, 48% said that the personnel recruitment system is not properly set up, 33% said that the allocation of posts is unreasonable, 31% said that the management system is unsatisfactory, 31% said that the personnel evaluation system is unsatisfactory, and so on. As many as 67% of respondents noted a lack of proper business practices and general systems.

To improve personnel-related problem, the highest percentage of respondents, 63%, indicated the need to clarify various institutions and norms (regulations) and create a system to protect the legal rights and interests of faculty and staff, 55% indicated the need to strengthen interaction and communication among faculty and staff, and 55% indicated the need to improve evaluation systems and reward and punishment systems.

The above is a list of problems noted in a relatively high proportion of responses and does not represent all problems and answers. However, it can be said that more than half of respondents in this survey experienced problems related to personnel affairs, and solving these problems required the optimization of evaluation systems and clarification of institutions under a strong administrative authority.

In contrast, subsequent decisions and opinions indicate that universities and scientific research institutions are moving in the direction of more flexible personnel management than in the past. The main reforms will be described briefly to avoid repetition. They include actively selecting leaders under the age of 45, adopting the "open competition" system in the selection of principal investigators, forming postdoctoral teams, and reforming evaluation systems by eliminating the "four only" standard and using quality, ability, and performance as the criteria for evaluation.

It is not easy to analyze in detail how the situation until just before the Xi Jinping administration, as shown in the results of the above questionnaire survey, was improved by the subsequent reforms regarding personnel management authority, and whether this led to a change in researchers' awareness. The key question is whether or not the needs of researchers are being met. It will be necessary to examine the actual situation more closely in the future.

In addition to reforms by the CPC Central Committee, the State Council, and other government agencies, local governments at all levels are also enthusiastically pursuing this type of reform, as exemplified by the "Article 10 Policies" of Sichuan Province announced on March 24, 2017, which expand the province's personnel autonomy.

Some of the major policies will be addressed below. First, the authority to conduct open recruitment (invitation of visiting researchers) was expanded, allowing each organization (business unit) to determine the conditions, time, and selection method for recruitment on its own initiative, to omit the review process by the administrative department,

369 Questionnaire survey by the Beijing Municipal Board of Education Funding/Central Project "Research on University Personnel Disputes in the New Era" (SM201110015004), estimated to have been conducted around October 2011 by project members led by Shi Jiemin of the Beijing Institute of Graphic Communication. The questionnaire was sent to 60 universities in Beijing, Shanghai, Guangzhou, and other provinces and direct-administered municipalities, including 33 key universities and 26 central universities. The survey was sent to 500 respondents, and 346 responses were received. Respondents consisted of 246 university faculty, 70 administrators, and 30 administrative assistants, of which 211 (61%) up to 40 years of age and 133 (39%) over 40 years of age.

and if necessary, to directly go abroad to recruit personnel with a master's degree or higher. This is extremely important. Regarding the mobility of human resources, the decision was made to allow scientific research personnel to hold concurrent positions freely, and also to allow them to move freely to universities and research institutions with the consent of the competent department without the need for permission from the human resources department[370]. The decision was made to expand management autonomy, making it possible to increase the proportion of senior professional and technical posts to some extent and allowing public recruitment of junior professional and technical personnel based on actual demand, regardless of percentage (proportion) restrictions on the number of posts, as long as recruitment does not fall below basic state or provincial recruitment standards. The policies allowed the creation of specialized technical posts and allowed recruitment to take place without any restrictions on the total number or percentage of posts. Evaluation came to be conducted more independently, evaluation by administrative management departments transitioned to ex-post notification management, and innovation and establishment of new projects came to be evaluated based on performance. With regard to the social insurance system, employers are now free to choose which system to use, and regardless of the type of insurance coverage, workers' compensation insurance is now mandatory and covers accidents on the job. Furthermore, universities and scientific research institutes are now free to set compensation based on the performance of their researchers. Especially in the case of technical services for enterprises, it was decided that there should be clear specifications for technology development, technology transfer, or technical advice. This made it possible to increase unplanned posts and offer the higher compensation required to attract senior personnel with the agreement of the competent department.

In addition to the above, under the government policy of expanding the autonomy of researchers, universities, scientific research institutes, and other organizations are simplifying the direction and route of research, eliminating budget management, diversifying compensation for researchers[371], flexibly handling travel and lodging expenses, and so on. Although these measures mostly embody the central government's basic direction, various efforts are being made to simplify research and enhance its flexibility, in line with the needs on the field. It will be important to determine the effectiveness of these efforts by conducting surveys that reflect the actual situation.

To understand the realities of other forms of management authority, we will cite the 2018 "Survey on the Actual Situation of Delegation of Various Authorities in Universities[372]." University faculties[373] are now able to set their own curricula and course offerings for specialized courses (required courses), whereas liberal arts courses (elective courses) remain heavily influenced by the university. However, universities tend to pass on work in areas for which they do not want to take responsibility to faculties under the guise of delegating authority, and some complain that this only increases work rather than authority. As for personnel management authority, some universities, such as Zhejiang University, have delegated all authority, including evaluation, to faculties, and others, such as East China Normal

370 The term "competent department" refers to the academic faculty or other institution to which the researcher belongs. In other words, originally, the human resources department (administrative department) controlled hiring (personnel management authority), salaries, and so on. Now, however, decisions are made by the faculty to which the researcher belongs, rather than the human resources department.

371 In a case study in Tianjin, this is called "three-part compensation," which refers to salaries paid under the structure of salary + earnings from projects + profits from conversion of achievements.

372 Zhang Leisheng, "Survey on the Actual Situation of Delegation of Various Authorities in Universities," Journal of Higher Education Management, 2017 (011) 003, 2017 Period 3 Vol. 11 2017, pp. 30-40. This paper is based on interviews with 22 respondents (11 managers and 11 general staff, 18 men and 4 women) from universities in Beijing, Shanghai and other areas (10 universities in Beijing and Shanghai and 12 regional universities). https://www.sohu.com/a/140694578_387110 (accessed December 21, 2021)

373 In China, university faculties are referred to as "院," and smaller departments are referred to as "系."

University, have had to revoke authority due to misconduct (e.g., hiring acquaintances) soon after it was delegated. In some cases, authority is divided equally, with the university and the faculty sharing the hiring process. In general, there is a strong desire for faculties to be in charge of hiring personnel. However, from the perspective of fraud prevention, it is seen as more appropriate for the university to make decisions on salary raises, promotions, and other matters.

Universities are also pursuing various financial reforms. Financial authority here refers to budgeting authority, revenue management authority, and the authority to independently use surplus funds. In a sense, although faculties are expected to independently exercise budgeting authority, the university is involved in the form of budget cuts for various reasons. Revenue management authority and the authority to independently use surplus funds are efficiently implemented at prominent universities, creating a virtuous cycle in which revenues are used to recruit and train personnel, and in turn, those recruits have an economic impact.

Overall, there is a strong opinion that faculties should have the authority to set up departments, manage students, manage scientific research, manage lectures, attract personnel, evaluate work, and manage budgets and expenses. However, the distribution of authority between universities and faculties tends to be more of a rivalry than cooperation. Universities are concerned and wary of delegating authority to faculties, doubting the effectiveness of this approach since there are few faculty personnel who can be considered to have high management skills, and the internal structures of faculties have not yet been established.

6.2 Researchers' evaluation of funding reforms

Having introduced a series of funding institution reforms, let us consider how researchers in the field perceive these changes. JST/APRC has examined the results of interviews with researchers (including junior, mid-career, and senior researchers) to date and tried to determine how much progress has been made in reform.

In fact, every five years, CAST conducts the "National Survey Report on the Status of Science and Technology Personnel" to survey science and technology researchers across the country and determine their work conditions and challenges. In this report, we will present the "Third National Survey Report on the Status of Science and Technology Personnel" published in 2013 (data is not yet available online for the 2018 "Fourth national survey report on the status of science and technology personnel").

First, let us look at what researchers thought of funding institutions and the research environment before this series of reforms.

Table 13: 2013 National Survey Report on the Status of Science and Technology Personnel

Question	Answer
① Do you think the research skills of researchers are lower than in developed countries?	74.1% said yes.
② Do you think there are many researchers who are not dedicated to research?	69.6% said yes.
③ Do you think there are few original scientific results?	82.5 said yes.
④ Do you think scientific evaluations are unreasonable?	68.2% said yes.

⑤ Are papers important in scientific evaluations?	81.8% said yes. *91.7% of researchers who had worked on funding projects in the last 3 years said yes.
⑥ Do you think the science and technology evaluation system is partly responsible for the occurrence of research misconduct?	52% said yes.
⑦ How effective are science and technology incentive programs?	26.2% said they had a significant positive impact, and 11.6% said they had a significant negative impact.
(8) What do you think about the allocation of science and technology resources?	28.4% said that the results of allocation are unfair. 26.6% said that the allocation process is unfair. 25.4% said that resource use is inefficient.
⑨ What problems do you think exist in the management and use of science and technology project funds?	① The percentage available for labor costs is too low (59.7%) ② The application cycle is too long (56.1%) ③ The review process is opaque (50.7%) ④ The application procedures are too complicated (48.8%) ⑤ The review process is unfair because it is influenced by personal connections (45.4%) ⑥ Funds are not received in a timely manner (36.1%) ⑦ Acceptance inspections are just a formality (33%) ⑧ Bid information is not disclosed (28%) ⑨ Funds are used illegally (16.7%)
⑩ Do you think you are mentally and physically healthy as a researcher?	50.2% said yes.
⑪ Are you satisfied with your career as a researcher?	54.9% said yes. *Satisfaction with promotions 26.3% Satisfaction with income 25.2% Satisfaction with the academic atmosphere of the affiliated institution 32.3% Satisfaction with the training received at the affiliated institution 28.5%
⑫ Are you happy as a researcher?	37.5% said yes.
⑬ Are you very stressed?	44.4% said yes. *55.2% of university faculty, 52.7% of other scientific research personnel, 49.1% of master's graduates, and 58.1% of Ph.D. graduates said yes.

(Prepared by the authors based on various sources)

Thus, before the reform, more than half of the researchers pointed out that the funding and evaluation systems were problematic. The number of papers was also shown to be very important in the various evaluations. Below, we will discuss whether researchers noticed any changes after the reform, based on interviews conducted in 2022.

(1) Researchers' administrative work has been greatly reduced

According to the survey, the area in which researchers feel the most change is the reduction of administrative work. Since the introduction of a fully online application process for funding projects, there are fewer documents to prepare, and the time required for application has been greatly reduced compared to the past. Some universities have even established new support offices to assist researchers in applying for funding projects and help them prepare materials.

In addition to providing answers to questions, the support office closely checks the materials for omissions and entry errors to ensure that the application will not be rejected due to incomplete materials. Research topics, technology paths, and other aspects of academic research are not discussed. When processing expenses, the traditional task of attaching receipts and organizing them by item has been eliminated, which is appreciated by researchers.

(2) Researchers' autonomy has steadily been expanded

Although most of the respondents said that the use of funds has become freer, others said that there are still implicit rules, that it is necessary to control expenses so that they do not differ significantly from those of similar funding projects, and that the rationality and necessity of the use of funds are questioned. Some respondents stated that reforms regarding the use of funds should be introduced gradually, expressing concerns that a sudden expansion of authority could lead to abuse or misuse of funds.

The common view is that the use of indirect costs has become freer, and the portion corresponding to researcher pay and bonuses has increased, which has made researchers more proactive. With more and more projects using the lump-sum system, and host institutions adopting the negative list[374], many researchers are noticing the change.

After the reform, when applying for projects, the opinions and intentions of the applicant are given the utmost respect. Researchers in doctoral programs who have little experience in applying for projects may apply under the guidance of their supervisor. However, the supervisor only gives advice and does not interfere with the researcher's research topic or technology path. When forming the research team, the project leader has personnel management authority, and there is little involvement by the administrative side.

(3) Support for women and young researchers has been strengthened

Compared to professors and well-established researchers, it is not easy for young researchers, including those who are still doctoral students, to apply for funding projects. In order to strengthen support for young researchers, new systems have been introduced, including open competition (open recruitment of innovation project leaders through self-referral, regardless of age and position) and horse-racing (competition, original term: 赛马). The NSFC is increasing the number of projects in its Young Scientist Program and Originality Exploration Program. These changes have greatly increased young researchers' chances to receive support from funding projects.

When doctoral students or postdoctoral fellows apply for funding projects, their supervisors and affiliated institutions do their best to support them with appropriate advice, to procure the necessary resources, and to help them achieve good results.

Opinions were divided on support for women researchers. Some believe that, because of limitations based on physiology and traditional culture, women are at a disadvantage in research activities and supporting them is reasonable and even desirable. In contrast, some argue that researchers should be evaluated on the basis of their knowledge and ability, and bringing gender to the forefront will make it impossible to guarantee the quality of scientific research projects and may lead to overprotection, which would be detrimental to fairness.

374 A system to list only items that should not be used. Original term: 负面清单

(4) There is still a long way to go to strengthen basic research

All of the researchers who responded to the survey stated that support for basic research has indeed been strengthened. Not only has more money been invested in basic research, but the number of funding projects related to basic research has also increased, making basic research a major topic for companies, universities, and research institutions alike. However, the overwhelming view was that the emphasis on basic research was "still insufficient." Although investment in basic research has increased, it is still under 10% of total R&D funds. Moreover, since many of the funding projects are more in the nature of applied basic research than pure basic research, there are questions as to how much investment in pure basic research has actually increased. Respondents also pointed out that overcoming the fundamental bottleneck of basic research requires long-term support, rather than a temporary policy focus, and that the importance of basic research needs to be recognized now more than ever. Some respondents stated that basic research is about more than just science and technology — What hangs in the balance is the fate of the nation.

(5) Establishing evaluation systems is an urgent issue

Reforms to abolish the "four only" standard are well underway, and these reforms are spreading to the provincial and municipal levels. Universities and research institutions are striving to completely eliminate the "four only" standard from researcher evaluations. However, new evaluation criteria and indicators to replace the "four only" have not yet been determined, and many researchers have expressed concern about proceeding with the reform without clear evaluation criteria. Today, as researchers come to rely on peer evaluation, they are seeking new evaluation criteria, focusing on the "quality of papers, substance of technology, and presence of innovativeness." Therefore, the establishment of new evaluation systems is a major issue that needs to be resolved urgently.

The criteria for selecting experts to conduct evaluations also need to be more clearly defined. For example, the evaluation of the Originality Exploration Program reflects more subjective judgments of experts than other programs, since it is based on peer evaluation. Opinions on "originality" can be divided among the experts who evaluate the project. In other words, the selection of experts is extremely important. The problem here is that there are only a limited number of high-level experts who can evaluate Originality Exploration Program applications, and the criteria for selecting the experts are unclear. According to the survey, more than half of the experts registered in the existing expert database were pre-selected by expert organizations, and it is unclear exactly what criteria were used to evaluate and select them.

(6) The academic atmosphere has become conducive to the pursuit of research

Scientific credit building is one of the key contents of the reform. According to the questionnaire survey, in the past, evaluation was mainly based on the "four only" standard, and there were many cases of misconduct such as devising ways to increase the number of papers, improving presentation techniques, and using personal connections. As a result, researchers who conducted their research ethically often did not receive a commensurate evaluation. Now, however, researchers who work diligently to achieve high-quality research are increasing, and academic research is gradually returning to the way it should be. Due in part to the tightening of control on discreditable acts in scientific research, academic misconduct is said to have been significantly reduced compared to the past.

Although deeper reforms are needed and some issues remain, many researchers view these changes positively, and the reforms are considered to be beneficial for researchers and for China's scientific research programs.

6.3 Chinese researchers' opinions on recent reforms

Thus far in this chapter, we have presented opinions from the Chinese scientific community and Chinese researchers on the reform of China's research system.

In this section, we will present the views of researchers in a wider range of fields based on the results of a questionnaire survey commissioned by JST/APRC in FY2021[375]. There are doubts as to how well the survey represents the actual situation, as only a limited number of researchers participated. However, it is worth referring to the survey as an indication of the opinions of researchers in the most recent period. The survey questions were developed by the APRC to fully reflect the Xi Jinping administration's efforts to strengthen basic research and reform scientific research management. Participating researchers were selected by relying on the network of the contractor, Japan TEPIA Corporation. Since each university or scientific research institute has different characteristics, the circumstances of researchers' environment may be different. Therefore, it is difficult to judge whether these voices can be considered to represent all researchers. However, it is our belief that by continuing to ask similar questions in the future, we will be able to get a better picture of the actual situation.

The answers given by the four researchers to each question are summarized and briefly presented below. As a caveat, when devising the questions, we decided that in light of recent events in China, it would be best to avoid framing the questions as seeking to elicit criticism of government policy. Nevertheless, we believe that the responses below are quite candid.

(a) Are the opinions of experts and researchers reflected in national policies? Can researchers freely apply for research funding? Are researchers' intentions respected when submitting project proposals? Are researchers benefiting from "open competition," that is, a self-referral process for innovation project leaders regardless of age or position?

Avenues for gathering expert opinions have been secured through formal and informal means, including meetings at the time of national planning and the use of an opinion page set up by the Ministry of Science and Technology. Young researchers apply for research funding under guidance, whereas professors and others are free to apply for research funding. The aim of "open competition," which contributes to the active participation of young researchers, is to disrupt the traditional academic cliques and organizational culture, and its effectiveness should be verified in the future.

(b) Regarding funding applications, do researchers receive sufficient support from the host institution, and are the administrative procedures for applying for and managing research funding not overly burdensome for carrying out the research? Are researchers benefiting from "green channels" (simplified procedures)?

Support from researchers' affiliated institutions is generous. In addition, the online system is simplifying the process and reducing the labor involved in budget management methods. The benefits of "green channels" are seen in the verification of topic selection, interim inspections, expanded autonomy in spending, and a system that allows ex-

375 See footnote 138.

post reporting. However, there is room for improvement in procedures for transferring researchers, uniformity of exemption criteria across organizations, and the aptitude of administrative personnel and quality of services.

(c) Is it easy to apply for ambitious projects? Is there an environment that is tolerant of the risks (potential for failure) associated with research? Are applicants held responsible for failure?

Regarding tolerance of risk, the Progress of Science and Technology Law clarified the responsibilities of researchers, and efforts are underway to create a system that is tolerant of failure, with the exception of misuse of funds, poor academic practices, and the like. However, challenging tasks require cooperation between science and technology management departments and host institutions. Since evaluation is difficult, and evaluation criteria based on market demand and other factors are vague, multidimensional and classified evaluation is important. There are still some problems, such as the lack of uniform standards for the investment of funds by state-owned enterprises.

(d) In recent years, there is a perception that China is exercising a certain flexibility in implementing policy modifications and changes. How does this process work? Are policies that emphasize research based on the new concept of “Zero to One” playing an important role in how research topics are selected and implemented in the field?

The current institutions are strategic and flexible, with a system that combines top-down and bottom-up approaches to policy-making. This is a system that finds solutions with respect for plurality and efficiency, and it can be considered as a planned economy under a market economy. Since it is easy to change policies, China’s approach is to try experimental methods, see what works, and then make them into policies. Respondents believe that under a communist government, the decision-making process can be quicker and more powerful in a short period of time. Science is moving in the direction of emphasizing basic research, and there is a need to acquire more original data. Attempts have also been made to conduct high-risk research, although this has been difficult due to unclear evaluation criteria.

(e) Do researchers (both applicants and participants) prefer to be respected in terms of project implementation, modifications, team composition, and setting of research periods?

In the past, there were unspoken rules such as advance preparation of doctoral research teams and invitation of certain experts to participate. Now that there are audits and whistle-blowing, however, the environment is centered on academic performance, and the guarantee of academic freedom and initiative by scientific research personnel is of paramount importance. Purely academic issues are decided between the professor and the applicant, and the university’s involvement is minimal.

(f) Are applicants free to select participants from participating institutions (universities, scientific research institutions, private enterprises, and other research institutions)? Furthermore, are these mixed teams able to conduct their work at any national or private institution?

Applicants are free to decide the composition of the team of participants, although selection from a list of collaborating partners may be facilitated in terms of reimbursement, and research of a confidential nature may be handled within the organization. The research site is usually the applicant's location, and using other facilities requires additional costs and procedures.

(g) Can applicants freely decide how the research funds will be used? Do researchers have a say in the allocation of indirect costs? Are researchers benefiting from the "lump-sum system," a policy that eliminates the distinction between direct and indirect costs and increases flexibility to enhance researchers' autonomy by minimizing restrictions on the percentage and use of funds?

Although the authority of researchers to use the funds has been expanded, the use of research funds is not completely free, due to such factors as respect for the principles of fitness for purpose and identity with similar research. However, the lump-sum system has gradually expanded the degree of freedom, eliminated budget review, interim inspections, and ex-post supervision (handled through negative lists), and reduced the administrative workload. In addition, indirect costs, such as administrative costs, are managed by the affiliated institution. However, the applicant also has significant authority to use the funds for performance incentives and other purposes.

(h) Do you consider the measures for identifying and nurturing young researchers and women researchers conducting innovative research to be adequate? Are provisions in place to encourage graduate students and postdoctoral researchers to actively participate in national research projects and the like? Can doctoral and postdoctoral researchers easily submit and modify research proposals?

Although there are inequities that stem from cultural traditions, there is no systematic discrimination against women, and support is adequate, although there are some implementation issues. Some graduate students can apply for research funding in their second year, but there are no particular support projects for graduate students. Opportunities for young researchers such as postdoctoral fellows are increasing due to support policies such as emphasis on basic research, "open competition," and the abolition of the "four only" standard.

(i) Are R&D personnel satisfied with their salaries and compensation? Is there a high proportion of non-regular employment among researchers at universities and research institutions? How significant is the difference in salary and compensation between non-regular and regular researchers?

Although there are income differences, the system is basically satisfactory. However, some respondents note that compensation is concentrated on a few excellent researchers and that the gap is widening. Although researchers in non-regular employment receive the same salary, their treatment may differ in terms of employee benefits and the like, and aspects such as equal access to opportunities may depend on the supervising professor.

(j) In China, there has been substantial growth in both the number of researchers and research funding. Has this been beneficial for the research field? Can research

funding from various sources — national and local governments, private enterprises, and foreign companies — be combined for use?

Government funding has remained the same, whereas funding from corporate groups has increased in some areas. Some universities have seen an increase in funding due to collaborative research with enterprises, resulting in a shortage of laboratories at such universities. The combined use of funding is not prohibited in principle, and it is not rejected in cross-sectional studies as long as it does not complicate accounting work.

(k) Is there an emphasis on basic research that requires long-term investment? Does funding tend to be channeled toward areas promising short-term benefits? Within China, are there perspectives suggesting that principal investigators need greater discretionary authority, particularly given that national funding carries numerous restrictions that make it challenging to utilize funds dynamically in accordance with scientific principles?

The government has adopted a policy of emphasizing basic research, and the increase in funding indicates that considerable emphasis is being placed on this area. In the past, evaluations would focus on short-term achievements. Now, however, steps are being taken to change this trend. Yet, there is a tendency for evaluation criteria to be abstract, and for evaluations to only examine short-term achievements, and the evaluation of achievements lacks sufficient depth. For this reason, it is desirable to shift the focus to long-term achievements by conducting third-party evaluations and diversifying evaluation methods. As the funding system has changed to a lump-sum system, the management and supervision system and the academic atmosphere may also gradually change. However, the budgeting standards and job evaluation criteria are confusing, and criteria such as tangible achievements and papers remain standardized. There are also concerns that the sudden expansion of authority may lead researchers to cross moral lines.

(l) Have evaluation methods that emphasize the "four only" standard been reformed? Are reviewers for funding projects being appropriately selected? Are reviews conducted fairly, and is transparency ensured through the disclosure of results or other means? Do foreign experts participate in these reviews?

The reform of the "four only" standard is being thoroughly promoted. Evaluation is mainly conducted through peer review, and classified and differentiated evaluation mechanisms, which require scientific evaluation systems and specific indicators, are a challenge for the future. Expert databases have been set up by expert organizations. However, the selection criteria are unclear and need to be improved by referring to examples from other countries. Third-party supervision and evaluation are important. Foreign experts occasionally participate in the initial review, but direct participation is rare and still insufficient.

(m) Do you believe an appropriate scientific review system exists for particularly ambitious projects, including the participation of suitable scientists (including foreign experts) in their evaluation?

Currently, review is conducted by registered experts, review materials are sent to experts abroad as well, the selection is fair, and the review results are rarely contested. In research programs such as the NSFC's Original Exploration Program, peer evaluation is the norm. The evaluation criteria are imperfect, and the need to conduct evaluations that are out of the ordinary is encountering resistance from some experts. The current evaluations are lacking in terms of assessing innovation. The problem is that there are few opinions from third parties such as enterprises and the market. Therefore, market competitiveness, finance, demand, and technological innovativeness are not always assessed.

(n) Are research achievements being evaluated appropriately (evaluation cycles and the selection of expert reviewers, etc.)? Do you think the results of the evaluation of research achievements are adequately reflected in the allocation of resources? What methods are employed for conducting follow-up assessments and post-completion evaluations to bridge basic research with industrial applications?

Efforts have been made to bring science and technology evaluation where it should be, that is, to a point where evaluation is based on scientific value. The culture of sectarianism and personal evaluation has been improved, and the evaluation of research achievements has become objective and fair. However, some challenges remain in terms of top-down approach, and future challenges include establishing a classified evaluation system, clarifying the criteria and scope of peer evaluation, making evaluation more scientific and service-oriented, promoting corporate participation, and increasing financial investment and marketization elements. In particular, basic research should transition to a long-term periodic evaluation and ex-post tracking mechanism. In-depth research after the preparation of papers and evaluation work after the commercialization of results are important. The attribution of achievements to researchers should also be revised in the future. Support for basic research and applied basic research through peer evaluation should be strengthened as well.

(o) Has the evaluation of research paper quality, rather than impact factor or number of papers, produced positive results? Have recent reforms in journal submission practices, including the increased emphasis on domestic Chinese-language journals, yielded positive effects on research implementation?

The emphasis on representative works in papers is as it should be, and the evaluation system based on scientific value has generated interest in original and experimental data, which has greatly enhanced the academic atmosphere. However, there is considerable variability in journals, and although it is good that emphasis should be placed on Chinese-language journals in particular, there is also a strong political component, which still needs improvement. In addition, researchers who contributed to Chinese-language journals to begin with said they did not feel particularly affected by the policy.

(p) What are China's future priorities in the field of R&D or in science management systems?

Emphasis on basic research and basic technology is an issue that can determine the fate of the nation. Yet, the current policies are still insufficient to produce highly original results. Further improvements are needed for independent innovation. Reforms related to evaluation, management, and credit have been implemented, but these matters require fundamental reform, rather than mere adjustment. It is important to develop a classified evaluation system for research achievements, and personal evaluation and a lack of scientific standards remain. In addition, the rate of conversion of research results into markets and patents is low.

While the above opinions may be perceived in a variety of ways, a few main characteristics can be observed in light of the purpose of this survey.

First, in terms of strengthening basic research, many researchers recognize that it is an important direction to pursue and report that relevant measures are in fact being taken. However, no clear distinction is made as to whether the basic research to be strengthened should be so-called pure basic research. Instead, what should be strengthened is understood to be basic research in general, including applied basic research.

Many researchers believe that the reform of scientific research management has actually achieved considerable progress, reducing and speeding up administrative work by enhancing simplicity and flexibility. In terms of evaluation, the respondents expressed satisfaction that the traditional bad practice of personal evaluation has been eliminated and evaluations are now based on scientific value. However, in terms of evaluation criteria, there seems to be lack of trust in peer evaluation, the so-called peer review method, and there is a strong demand for selection criteria for the experts who conduct the review, objective criteria for evaluation, and third-party evaluation. In addition, participation by foreign experts seems to be uncommon. No specifics are provided for these “objective standards,” suggesting the difficulty of formulating these standards. There is also a sense of expectation about the function of the market, a sort of “evaluation by the market.” However, it is not always clear how this evaluation by the market should be recognized and carried out. Generally speaking, the question is whether research achievements will be utilized as industrial technology. However, this seems to imply that it is still more advantageous to conduct applied basic research. Some have expressed critical views of the matter, citing the need for improvement in the distribution of research achievements and the low rate of conversion to patents or to the market itself.

7 Differences in the Environment of Chinese Researchers Compared to the U.S., Europe, and Japan

The above chapters reviewed the status of basic research promotion and scientific research management reform in China. However, rather than socialism with Chinese characteristics, China is adopting a unique approach which may be difficult to understand from the outside. Gauging the true value of this approach is a challenging task. Therefore, it is important to determine what indicators should be used to make a judgment. These could include innovation ranking, intellectual property rights fees, number of patent applications, and more. While such indicators are important, we also want to value distinctive sensibilities in conducting science. Finally, we will address four effects of these sensibilities which have created an environment that is different from that of Japan, the U.S., and Europe.

7.1 "Freedom of scientific research" in China

Article 47 of the Constitution of the People's Republic of China stipulates: "Citizens of the People's Republic of China shall enjoy the freedom to engage in scientific research, literary and artistic creation, and other cultural pursuits. The state shall encourage and assist creative work that is beneficial to the people of citizens engaged in education, science, technology, literature, art and other cultural activities."

The "Fourteen opinions on the current work of natural science research institutions" issued by the Central Science and Technology Commission and CAS in 1961 aimed to "guarantee (...) some freedom of choice of topic, as well as to guarantee the Party's leadership and responsibility in scientific research institutions." We have mentioned that the choice to use the term "freedom" in official government opinions during this period was noteworthy. The late 1950s was a time when, aside from the political context, there was a movement to encourage free speech and to build a Chinese Communist state that was different from the then Soviet Union. The movement's slogan was "Let a hundred flowers bloom, let a hundred schools of thought contend." At that time, the period of turmoil known as the Cultural Revolution was yet to come. However, we would like to consider the nuances of the concept of "freedom" in China's attempts to conceptualize new economic and social institutions.

In 1985, after the Cultural Revolution, the "Decision on the reform of science and technology systems" proposed "stabilizing one part to liberalize another" in order to "adjust science and technology policy in relation to the market economy." However, "free research" was allowed only within the scope of "contribution" to social and economic construction. Article 3 of the Progress of Science and Technology Law stipulated: "The State guarantees the freedom of scientific research and technological development, encourages scientific exploration and technological innovation and protects the legitimate rights and interests of scientists and technicians."

In the early 2000s, the "Outline of the National Medium- and Long-Term Program for Science and Technology Development" placed more emphasis on the promotion of basic research, stating: "The development of basic research shall adhere to the principle of combining meeting the national objectives and encouraging free exploration. In addition, basic research activities shall observe the law of scientific development, respect scientists' exploratory spirit, and pay more attention to the long term value of sciences, with stabilized support [and] visionary deployment." The combination of "meeting the national objectives" and "encouraging free exploration" had finally made its appearance. The "Outline of the National Innovation-Driven Development Strategy," which was formulated in the 2010s, called for strong support for the "free exploration of basic research." However, it also noted that researchers should be guided to aim for "key breakthroughs" in technology. We can only conclude that this strategy was not intended to allow researchers to focus solely on pure exploratory research.

The word "freedom" is not mentioned in the 11th Five-Year Plan. The 12th Five-Year Plan only states that China will "actively create an academic environment that fosters free exploration and leads interest-driven scientific research to focus on the strategic needs of the nation." Again, no particular mention is made in the 13th Five-Year Plan. Among several opinions issued during that period, the "Opinions of the State Council on the overall strengthening of basic scientific research," issued on January 31, 2018, set the following goals: "Encouraging the organic combination of free exploration and goal-directed guidance. Focusing free exploratory basic research on investigating unknown scientific issues and boldly aiming for new heights in science. Firmly linking goal-oriented basic research to the needs of economic and social development and strengthening forward-looking planning in strategic areas." Although these opinions call for "free exploration," they clearly counterbalance this with a "goal-oriented" approach. The "Guidelines for activities to strengthen basic research and achieve 'Zero to One'" issued on January 21, 2020 call for "strengthening the creation of an academic culture, advocating academic freedom and democracy, adhering to a good, sincere, truth-seeking approach, avoiding a careless and frivolous atmosphere as much as possible, establishing honest, sincere, and correct instruction, being dedicated to patriotism and the nation, sincerely upholding trust, and promoting a scientific spirit that does not emphasize fame and profit." Even though "academic freedom" is being proclaimed, this freedom should not be "careless and frivolous." Furthermore, on May 28, 2021, General Secretary Xi Jinping's "Speech at the 20th Congress of Academicians of the Chinese Academy of Sciences, the 15th Congress of Academicians of the Chinese Academy of Engineering, and the 10th National Congress of the Chinese Association for Science and Technology" announced an "improvement of classified evaluation systems for free exploratory and mission-oriented science and technology projects." This "classification" will be discussed below.

The 14th Five-Year Plan states: "We will strengthen leadership through applied research and encourage free exploration." The plan specifically mentions evaluation systems in terms of "improving free exploration and mission-oriented classified evaluation systems." "Applied research" seems to be the only way forward.

In the "Progress of Science and Technology Law," which was amended in late 2021, the amended version of Article 68[376] states, "The state encourages scientific and technological personnel to engage in free exploration and take risks with courage and creates an atmosphere that promotes innovation and tolerates failure." However, the law goes on to state, "If the original records prove that the scientific and technological personnel who undertook exploratory and high-risk projects have exercised due diligence but are still unable to complete the projects, they shall be exempted from responsibility." This places a heavy burden on the project team to be able to provide a detailed explanation of their efforts to exercise due diligence.

Although the relevance to freedom of research is debatable, "a management system that immediately stops tasks that are not progressing well, and a system of responsibility that incorporates a 'declaration' structure with the aim of

376 Article 56 of the Progress of Science and Technology Law before the amendment stipulates almost the same.

completing the goals as planned[377]" are not conducive to research that welcomes free ideas.

Although the point is slightly different, in December 2019, several sources reported[378] that Fudan University in China had removed the section on "freedom of thought" from its university charter and instead included a pledge of allegiance to the Chinese Communist Party. Amid the promotion of free exploratory research, such a move seems to restrict the ideas and actions of researchers in some way. The Academic Freedom Index 2020 currently gives China a score of 0.082[379]. From the standpoint of those who seek to uphold the basic system of governance by the Communist Party, the "freedom" given is conditioned by this basic structure of governance[380]. Both academic freedom and scientific research freedom are premised on researchers' ability to choose their research projects without any constraints. As long as this basic issue is not understood, researchers will not enjoy academic openness and cannot be truly effective no matter what documents are issued. We have written about this at length, but as discussed in previous studies, it comes down to the argument of Ito Asei, who says that "innovation is unlikely to occur in so-called authoritarian regimes."

7.2 Effects of classification and evaluation

The term "classification" is frequently used in Chinese policy documents related to the management of scientific research or the evaluation of basic research. Article 8 of the Progress of Science and Technology Law stipulates: "The State establishes and improves an appraisal (evaluation) system for science and technology conducive to independent innovation. The appraisal system for science and technology shall be applied through classified appraisal on the basis of the characteristics of different scientific and technological activities and in adherence to the principles of fairness, impartiality and openness." Frankly speaking, the idea of classified evaluation is difficult to understand.

Classified evaluation is applied not only to the assessment of research results, but also to research proposal applications and personnel matters. Some examples of its usage in the policy documents we have discussed are listed below.

For example, in the 13th Five-Year Plan for Science, Technology and Innovation, among its measures to "Improve the Classification, Evaluation, and Incentive Mechanism for Scientific and Technological Talent" for the evaluation of personnel involved in basic research, the government will "improve talent evaluation and assessment methods, emphasize character, ability, and performance evaluations, and implement the classified evaluation of scientific and

377 [21-038] National Key R&D Program of China Introduces Open Recruitment System for Principal Investigators Regardless of Position, etc., Pekin Tayori, 21-038, June 11, 2021, JST Beijing Office, https://spc.jst.go.jp/experiences/beijing/bj21_038.html (accessed December 23, 2021)

378 "Fudan University Removes 'Freedom of Thought' Text from University Charter," December 21, 2019, National Institute of Informatics (NII) Research Center for Open Science (RCOS), https://rcos.nii.ac.jp/miho/ 2019/12/20191221/ (accessed December 24, 2021).

379 Scores range from 0 to 1. The closer to 0, the smaller the degree of freedom. Incidentally, the U.S. and Japan are at 0.901 and 0.711, respectively, while Italy is higher at 0.969. Education International, "Global index finds most countries do not respect academic freedom and shows signs of decline", published 14 April 2021, updated 29 April 2021, https://www.ei-ie.org/en/item/24856:global-finds-most-countries-do-not-respect-academic-freedom-and-shows-signs-of-decline (accessed January 22, 2022)

380 "In the first place, Confucianism is a fine way for people to maintain the vertical order in a static, agricultural society. Until the Qing dynasty, scholar-officials believed that commercial activities and manufacturing were the livelihood of the lower classes, and that the more thriving commerce became and the more fluid society became, the more order and customs would be disturbed. Free ingenuity, when taken to the extreme, is even an enemy of the vertical order." Hirano Satoshi, "The history of 'anti-Japanese' China's civilization," Chikuma Shinsho 1080, p. 82.

technological personnel." This means that research talent, that is, researchers, will be subject to classified evaluation. In the same plan, the government sets out to "restructure the national science and technology plan in accordance with the five types of science and technology plans," including "the National Natural Science Foundation of China" and "the National Science and Technology [Major] Projects," "implement categorized management and categorized support," "integrate all science and technology plans (...) into a unified national science and technology management platform, improve the operation mechanisms for inter-ministerial joint meetings on national science and technology plans (...), strengthen the management of scientific and technological plans and the overall coordination of major events, and give full play to the role of industries, departments," and the judiciary. This refers to the classified evaluation of projects. Regarding the evaluation of research achievements themselves, the section entitled "Improve Innovation-Oriented Evaluation Systems" states that the government will "establish a classification and evaluation system guided by the quality, contributions, and achievements of scientific and technological innovation, and correctly evaluate the scientific, technological, economic, social, and cultural value of scientific and technological innovation achievements." Moreover, it is clearly stated that "evaluation results" will be used "as an important basis for government funding for science and technology." This point was further addressed in the "Opinions of the State Council on the overall strengthening of basic scientific research," issued on January 31, 2018. The opinions note that the government will be "aiming for the cutting-edge of global science and technology, strengthening basic research, deepening the reform of science and technology institutions, and promoting comprehensive innovation and development in basic and applied research." The Guiding Principles are "Following the laws of science and classified guidance." Thus, the idea of classification is elevated to the highly comprehensive concept of "classified guidance." In addition to this, the Central Office of the Communist Party of China and Central Office of the State Council "Opinions on further strengthening credit building in scientific research" issued on May 30, 2018, implemented a "one-vote veto system" (a system that allows rejection with one dissenting vote) as part of the construction of the classified evaluation system, demonstrating the thoroughness of the system.

After reading the above quotes, the weight of the term "classification" should be readily apparent. This is an important guiding concept to place researchers in a certain frame of mind when making judgments and to define and color their thoughts and actions. The "one-vote veto system" mentioned at the end is an extreme case in which classification is instantly determined by a single vote (a single person's judgment). The institutional establishment of such a decisive moment must have an unimaginable impact on the daily thoughts and actions of researchers and may even have the psychological effect of inducing fear in researchers. This is another mechanism that is introduced to ensure the thoroughness of classification.

As a method, however, classification can be said to be a fundamentally natural act of human beings when performing scientific work. Information is fundamentally a form of classification. Thus, the term is not originally associated with discrimination or fear. Indeed, in Europe and the U.S., classification is used in funding agency reviews, screenings for employment in research institutions, and promotions at universities and scientific research institutions. This type of classification does not immediately strike fear into the hearts of researchers. In fact, it is part and parcel of a competitive society. However, of course, acceptance of this system can only be based on trust in a society where values such as fairness, equality, and transparency are thoroughly upheld. China's Progress of Science and Technology Law states the need for "classified appraisal (...) in adherence to the principles of fairness, impartiality and openness." However, the impression of classified evaluation we are left with is not consistent with fairness, impartiality and openness. Let us consider why that is.

Perhaps, it is because the pressure imposed by the severity of credit measures and evaluation results are beyond the scope of what we ordinarily encounter. The concrete realities of research integrity will be examined in detail in a later section. However, regarding the consequences of paper fraud and other discreditable acts, for example, the government has stated: “We will adhere to a zero-tolerance policy, maintain a high-pressure stance of strictly combating acts that seriously violate the requirements of scientific research credit, and rigorously hold accountable those who have committed such acts. We will establish a lifelong pursuit system against acts that seriously violate the credit requirements of scientific research established by laws and regulations and investigate and deal with such conduct as soon as it is discovered. We will actively implement criminal regulations and theoretical research on acts that seriously violate the credit requirements of scientific research and promote the timely announcement of appropriate criminal sanctions by the legislative and judicial branches of government.” Specifically, “We will impose punishments such as cancellation of project application eligibility, recovery of project funds, revocation of honorary degrees, recovery of prize money, expulsion from the academic register, cancellation of degrees and other qualifications, revocation of medical licenses, and other measures. Further penalties will include potentially lifelong cancellation of promotions and titles, application eligibility, appointment as an evaluation expert, and candidacy for graduate degrees, as well as termination of labor contracts and prohibition from engaging in teaching and research work.” Any “acts that seriously undermine credibility will be entered in a database and added to an observation list.” Those who are “public officials will be subject to punishment by law or other means, Communist Party members will be subject to party discipline, and criminal acts will be turned over to judicial authorities.” Moreover, “joint disciplinary action” will be taken, and “various reviews and evaluations of project applications, appointments, employment, and so on, will be linked to credit status, which will be an important reference for administrative approval, public procurement, priority evaluation, financial assistance, funding grade evaluation, tax credit evaluation, and so on[381].” These are severe measures that could cause researchers to lose not only their careers, but also, in a sense, their positions as private citizens. Operating in a world where something like that could occur would force anyone to act with caution, even if they had no intention to commit discreditable acts. Classified evaluation may be the gateway to that very world. The words “fairness, impartiality and openness” may not carry enough weight to balance a strict system of classified evaluation that determines the course of people’s lives.

7.3 Degree of organizational involvement

According to the above-mentioned Futao Huang (Professor, Research Institute for Higher Education, Hiroshima University)[382], among CPC secretaries and deputy secretaries at Project 211 universities and Project 985 universities (usually three to four people), only 4% and 5.3%, respectively, hold some kind of foreign degree. Of course, we should not use these data to draw simplistic conclusions. However, it appears that even among universities that have been selected by the government, international academic experience is rare, and not all are managed by administrators who are familiar with international structures and operations.

In his above-mentioned book, Isa Shin’ichi wrote: “Still, it seems that freedom of study and research is not fully

381 Central Office of the Communist Party of China and Central Office of the State Council, “Opinions on further strengthening credit building in scientific research” (May 30, 2018), (20).

382 Futao Huang (2017) Who leads China’s leading universities?, Studies in Higher Education, 42:1, 79-96

guaranteed. Sometimes, the most important judgment is that of the organization to which one belongs, including the Communist Party organization. The presence in the Chinese research environment of judgment entities that are more important than scientific and objective judgments, and that are sometimes unscientific and subjective, is a factor that hinders the development of science and technology in China[383].” Citing several examples, he states that indeed, “in China, political judgments are often more significant than scientific and objective analysis. There is no doubt that, sometimes, the very analysis that should be scientific and objective is distorted by political agendas[384].”

In contrast, Hayashi Yukihide wrote in his book: “No Chinese researcher or university student I have ever met has expressed dissatisfaction with CPC delegates, or with their words or actions. Rather, I often heard stories touting the close relationship between their organization and the CPC. Amid China’s economic growth, there does not seem to be much of a conflict of interest between researchers involved in science and technology and the officials dispatched by the CPC, and the two are able to coexist peacefully.” Moreover, “CPC delegates are considered to be very valuable, either at the behest of the CPC or out of a desire to make good use of the CPC’s authority[385].” Needless to say, Chinese researchers would not necessarily express complaints about “Communist Party delegates” to a visitor from a foreign country coming to study Chinese universities. We might even say that views like this one promote a positive evaluation of relationships with the Communist Party, and in turn, prevent any doubts from being raised about the legitimacy of the Communist Party rule. Hayashi’s point of view of “peaceful coexistence” is, of course, based on relationships of positive coexistence with the Party in the midst of economic development.

The degree of organizational involvement may not depend solely on the presence of the Communist Party at universities and scientific research institutions. Organizational involvement, which will be examined here, is an issue that has been discussed in terms of how it can force organizations to become involved in the execution of research activities that should be undertaken individually by researchers. As a reference, we looked into what sort of organizational involvement is required in the guidelines of the U.S. NSF, a typical funding agency.

The NSF has formulated guidelines for project proposals, grant disbursements, and procedures in a document entitled “Proposal and Award Policies and Procedures Guide (PAPPG:)” (NSF 20-1)[386]. The latest revision has been in effect since June 1, 2020. These guidelines give an overview of the necessary procedures related to proposals made by applicants, including the aspects involving the institutions to which the applicants belong. These are the provisions that are being discussed in this section. These provisions, by category, are listed below:

Ethical training for researchers involved in applied research proposals, including doctoral students and postdoctoral fellows, and the appointment of a person responsible for conducting such training (2.C.d.); Requirement of institutional oversight when the research proposal involves Life Sciences Dual Use Research of Concern as defined by Federal law (*Ibid.*); Approval from the Institutional Animal Care and Use Committee when experiments involving vertebrate animals are to be conducted (2.D.4.); Approval from the Institutional Review Board when experiments involving human subjects are to be conducted (2.D.5.); Obligation to conduct investigations into claims and other matters under federal laws and regulations relating to the prevention of discrimination (6.a.2.).

383 Isa Shin’ichi, *op. cit.,* p. 183

384 See Isa Shin’ichi, *op.cit.,* p. 188 onwards.

385 Hayashi Yukihide, *China as a Science and Technology Superpower*, Chuokoron-sha, July 2013, p. 153

386 Significant Changes and Clarifications to the Proposal & Award Policies & Procedures Guide (PAPPG) (NSF 20-1), Effective Date June 1, 2020, https://www.nsf.gov/pubs/policydocs/pappg20_1/nsf20_1.pdf (accessed August 23, 2020)

These obligations listed in these provisions are not specific to the function of funding but are basic requirements for all institutions that conduct research and are fundamental to the conduct of publicly funded research. These are matters that should be handled appropriately by the organization rather than being the responsibility of the individual researcher submitting the application. Therefore, it is only natural that organizational involvement should be sought here.

Now, let us consider what kind of organizational involvement in sought in Chinese funding. To a limited extent, we will try to identify some of these issues based on the systems involved in the implementation of the National Science and Technology Plan.

The first step is project application. Organizational involvement at this stage is seen in the procedures of the Ministry of Science and Technology's "National Key R&D Program of China[387]" (below, "the procedures")[388]. Section 1.3 of the procedures states, "The project applicant organization and the principal investigator shall sign a letter of consent in good faith." This means that the principal investigator, or the person responsible for carrying out the research, cannot apply without the consent of the organization to which they belong. In these procedures, "the applicant organization" is considered to be the entity that applies. In the same section, it is stated: "Each recommending organization shall strengthen the review of the recommended project application materials and report the recommended projects in summary through the National Science and Technology Management Information System by the deadline." However, section "2. Application Eligibility Requirements" states that, in the first place, "the project of an applicant organization should be applied for through a single recommending organization, and no duplicate application for the same project should be made through another organization." In addition, section "4. Specific Application Methods 2" states: "Each recommending organization should send a letter of recommendation bearing the stamp of the organization and a list of recommended projects to the Information Center of the Ministry of Science and Technology (by the deadline)." This means that projects must be proposed through and with the endorsement of certain recommendation mechanisms (the types of recommendation mechanisms are specifically defined in section 2 of the procedures). It is not clear exactly how these recommendation mechanisms function. However, the organization to which the applicant researcher belongs plays a crucial role in the application process, which implies further organizational involvement. In fact, the applicant cannot propose a project without a recommending organization through which to submit the application.

Next, let us look at organizational involvement at the fund management stage in the procedures of "scientific research projects funded by the central government[389]." In these procedures, additional reforms were introduced to more thoroughly implement various previous reforms, and several reforms were basically adopted under the so-called policies to "delegate power, streamline administration, and optimize government services." Therefore, rather than strengthening organizational involvement, the reforms are going in the direction of reducing that involvement. For the

387 In China, funding includes various national science and technology programs, such as the National Key R&D Program of China, which is directly under the jurisdiction of this Ministry of Science and Technology, and so-called research subsidies disbursed by the NSFC. The former are sometimes described as "scientific research projects funded by the central government."

388 JST China Research and Communication Center, "Current Status and Prospects of China's Science and Technology Policy," p. 60, "Ministry of Science and Technology's National Key R&D Program of China: Notice on 2017 Project Application Guide for New Energy Vehicles and Other Major Special Projects, National Science and Technology Development Fund [2016] No. 305," https://spc.jst.go.jp/investigation/downloads/r_2017_03.pdf (accessed August 24, 2021)

389 Japan Science and Technology Agency, China Research and Communication Center, "Current Status and Prospects of China's Science and Technology Policies," p. 64, "Opinions on further development policies, including management of funds for scientific research projects funded by the central government" (accessed August 24, 2021)

purposes of this report, this is commendable as an institutional improvement to discover and promote excellence in the Chinese research system. However, the move toward "standardizing management" and "strengthening corporate responsibility," which appears to be somewhat contrary to the purpose of the reform, has been further advanced under the slogan "delegate power, streamline administration, and optimize government services." This is evidenced by the following provisions: "The projects' host institution will steadily implement relevant national policies and regulations, strengthen its autonomy and self-imposed norms under the principle of unity of authority and responsibility, and guarantee the undertaking and daily management of its work. The host institution will establish internal control methods and implement management authority for project budget adjustments, overarching use of indirect costs, control of personnel cost allocation, and use of surplus funds. Safety, standardization, and effectiveness in the use of funds will be guaranteed by strengthening budgetary review, standardizing financial expenditure acts, developing an internal risk prevention system, and reinforcing performance-based evaluation of the use of funds." As examples of such organizational involvement in fund management and budgeting in the U.S., although the names of institutions vary from university to university, the above-mentioned SPAO provides assistance in preparing and submitting research grant applications, and the Research Foundation Office (PFO) is responsible for managing grant funds after they have been disbursed and tracking their use[390]. The U.S. example demonstrates ways of relieving researchers from the administrative tasks associated with research. It is important to make sure that organizational involvement serves this purpose.

Above, we have examined fund management. Now, we will move on to "supervision management," which introduces various forms of involvement that can be considered the quintessential organizational involvement.

In the "Supervision Management Regulations[391]," supervision management refers to "the inspection, guidance and censure of science and technology programs, projects, fund management and their execution, to promote scientific and standardized management, impartiality and openness, and to enhance the effectiveness of the use of government funds for science and technology" (Article 2 of the regulations, below likewise). The main objects of supervision are: "The status of fulfillment of responsibilities in the project management process"; "The status of implementation of the corporate responsibility system of the project's host institution"; "The status of fulfillment of responsibilities of experts and support organizations participating in management and supervision"; "The status of credit and fulfillment of responsibilities of scientific research personnel in project implementation and in management and use of funds" (Article 3). In essence, this is a mechanism to hold the host institution (the organization conducting the research) and the researcher accountable. Although these regulations are not specifically listed and discussed here, their characteristics are described below. The Ministry of Science and Technology and the Ministry of Finance will "conduct random sampling investigations into the management and use of projects and funds," "strengthen feedback and operation of supervision and management results, and establish a unified credit system for scientific research." (Article 7) The responsibilities of each supervisory position will be defined through a hierarchy of government-related departments, regions, specialized project management agencies, and host institutions (Articles 8 through 12). The clarification of the responsibilities of the Ministry of Science and Technology, the Ministry of Finance, and the host institution

390 Suga Hiroaki, *op. cit.* pp. 56-58

391 Japan Science and Technology Agency, China Research and Communication Center, "Current Status and Prospects of China's Science and Technology Policy," p. 67, "Provisional Regulations on the Supervision of Science and Technology Programs (Specific Projects, Funds, etc.) Funded by the Central Government," https://spc.jst.go.jp/investigation/downloads/r_2017_03.pdf (accessed August 24, 2021)

with regard to supervision management put considerable pressure on researchers. In addition, outside supervision is added to this as well. Each supervising entity is supposed to share the problems it has discovered and the relevant improvement plans, strengthen enforcement against noncompliance, establish a system for holding responsible parties accountable by publicizing the results of the process, establish a system of credit and punishment, and establish a blacklist system, among other tasks. Considerable implementation effort is systematically invested in the design and construction of special or routine systems of day-to-day management supervision from the top level to the front lines in the field. This is linked to the record of discreditable acts described in the latter section. However, it is clear that the organization has a prominent role in supervising and managing the implementation of projects by researchers. Finally, “Scientific researchers and experts are obliged to uphold the spirit of scientists, adhere to scientific research integrity, enhance their sense of responsibility, strictly comply with various regulations on scientific and technological planning, project and fund management, and voluntarily accept relevant supervision management,” (Article 21) so as to adhere to moral norms. External supervision assigns a “credit” rating to host institutions, which determines the calculation of indirect costs and the degree of supervision. In particular, “For project contracting organizations with low credit ratings and the projects they undertake, appropriate supervision shall be carried out” (Article 29). Furthermore, the results of supervision are considered an important factor in the allocation of central government funding (Article 37). These measures are quite strict. Of course, a high credit rating has its advantages, such as the ability to use surplus funds as direct costs for scientific research activities and reduced frequency of or exemption from supervision.

Thorough compliance in research activities should be ensured as a matter of course. The organization to which the project leader belongs has a social responsibility to establish the systems necessary for this purpose and ensure their implementation. This cannot be viewed as excessive organizational involvement, but rather as the establishment of a general system that focuses on the most severe cases while overlooking the particularities of various individual cases, and the thorough mobilization of organizational activities to the point where they seem to severely restrict individual thought and action. This results in a sort of closed loop, for example, when loss of credit leads to financial sanctions. The negative impact of such organizational involvement on researchers must be considerable.

7.4 Research integrity and discipline

Research integrity or research ethics have been discussed in previous sections on perceptions of basic research and the current state of journals. The term “research integrity,” which has acquired the broader meaning of ensuring transparency and social fairness, is used in this report. This term is considered to include research ethics, which has a strong connotation of professional ethics, including prevention of paper fraud and misuse of funds. When discussing China’s problems, we will focus on the latter concept, which has a strong ethical dimension. Regarding the nuance of research integrity, a recent problem in the U.S. has been the lack of transparency in researchers’ conduct inspired by China’s “Thousand Talents Program” (e.g., receiving research funds from the Chinese government without disclosing it, receiving public funds from the U.S., or maintaining contractual relationships with affiliated universities in the U.S.). This is an issue that originates from China in the first place, and it is highly doubtful that China will confront problems of this nature in the future. Therefore, it is not necessarily appropriate to include this nuance in the discussion here[392].

In the United States, the issue of science integrity, or research integrity, began to be raised in the early 1980s, particularly in Congress. The Health Research Extension Act of 1985 required the Secretary of Health and Human Services to establish regulations and report on the prevention of scientific fraud[393]. Several administrative departments were subsequently established, culminating in the creation of the Office of Research Integrity (ORI) in the Department of Health and Human Services (HHS) in 1992. This laid the foundation for today's administrative structure and set the direction for various regulations[394]. In view of this history, it can be said that in the U.S., social awareness of research integrity has been high from a fairly early stage, and an institutional framework has been developed to govern the behavior of the researchers and institutions concerned.

In Japan, the MEXT "Guidelines for Responding to Misconduct in Research[395]" were adopted on August 8, 2006. Following the approach and methodology of the Office of Research Integrity in the U.S., these guidelines define fabrication, falsification, and plagiarism (FFP) as the three major types of misconduct that violate research ethics, establishing the institutional framework for research integrity in terms of so-called "paper fraud." The 2007 "Guidelines for Management and Audit of Public Research Funds at Research Institutions (Implementation Standards)[396]" (approved by the Minister of Education, Culture, Sports, Science and Technology on February 15, 2007; amended on February 18, 2014), and the 2016 "Guidelines on Responses to Misconduct in Research Activities[397]" (approved by the Minister of Education, Culture, Sports, Science and Technology on August 26, 2014) were established to ensure proper management of public research funds.

In China, the problem of research integrity emerged as a serious policy issue at the beginning of the twenty-first century, when the country was confronted with problems such as the duplicate submission of papers. In 2006, it was discovered that the Chinese-made Digital Signal Processor (DSP) Hanxin, which Professor Chen Jin of Shanghai Jiao Tong University claimed to have developed, was in fact a fabrication that used Motorola's DSP and other companies' technologies. Since then, the Education Division and CAST have made efforts to educate students, post-doctoral fellows, and researchers, and the NSFC, CAS, and CAST have also taken steps to develop a code of ethics and revise personnel standards accordingly. In particular, the NSFC has been focusing on reviewing applications for redundancy and novelty[398].

392 The term "research integrity" can also imply freedom from foreign influence and interference, but we will not include this meaning here.

393 Congress took action in 1985 by passing the Health Research Extension Act. The Act, in part, added Section 493 to the Public Health Service (PHS) Act. Section 493 required the Secretary of Health and Human Services to issue a regulation requiring applicant or awardee institutions to establish "an administrative process to review reports of scientific fraud" and "report to the Secretary any investigation of alleged scientific fraud which appears substantial."
https://ori.hhs.gov/historical-background (accessed August 25, 2021; below likewise)

394 In May 1992, OSI and OSIR were consolidated into the Office of Research Integrity (ORI) in the OASH.

395 Guidelines for Responding to Misconduct in Research: Report of the Special Committee on Misconduct in Research Activities, August 8, 2006, Special Committee on Misconduct in Research Activities, Council for Science and Technology,
https://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu12/houkoku/__icsFiles/afieldfile/2013/05/07/1213547_001.pdf (accessed September 2, 2021)

396 https://www.mext.go.jp/content/210201-mxt_sinkou02-1343904_21_1.pdf (accessed September 2, 2021)

397 https://www.mext.go.jp/b_menu/houdou/26/08/__icsFiles/afieldfile/2014/08/26/1351568_02_1.pdf (accessed September 2, 2021). In addition, there are "Guidelines for the Proper Use of Competitive Funds" (September 9, 2005, Inter-Ministry Committee on Competitive Funds) (https://www8.cao.go.jp/cstp/compefund/shishin1.pdf, accessed September 2, 2021).

398 Wei Yang, "Research Integrity in China," Science, 29 Nov 2013:Vol. 342, Issue 6162, pp. 1019,
https://science.sciencemag.org/content/342/6162/ 1019.full (accessed 31 August 2021)

As noted above, it has often been said that research integrity problems in China, aside from the social and cultural background, are due to the fact that in the world of scientific research, the quantity of papers tends to be more important than their quality in determining salaries, promotions, awards, and other personnel matters, as well as financial support for research projects. The issue of research integrity has been frequently discussed in articles in *Nature* and other publications, which expressed surprise at the dramatic increase in the number of papers and citations and reported that the issue is a social problem unique to the Chinese scientific community.

Under these circumstances, strict measures such as those mentioned above have been taken to adopt a “zero tolerance” policy. One of the strongest measures taken by the Xi Jinping administration is the “Provisional Regulations on Recording Serious Discreditable Acts in the National Science and Technology Plan (Special Projects, Funds, etc.)[399],” issued on March 25, 2016. One of the goals of these regulations is to “strengthen the establishment of a credit system in scientific research” (Article 1). In this context, “serious discreditable acts” are defined as “misconduct, noncompliance, disciplinary violations, and illegal acts committed in the performance of scientific research, which have serious consequences and adverse effects” (Article 2). The regulations include detailed measures for the recording of such discreditable acts and state that discreditable acts committed during the entire process of application, planning, implementation, management, and acceptance inspection by the responsible entities involved in the project will be objectively recorded (*Ibid.*). The Ministry of Science and Technology will oversee the management and application of these records. The information recorded will be shared with the relevant departments to administer rewards and punishments (Article 5). Major violations will also be reported to the Joint Meeting of the National Science and Technology Planning and Management Department (*Ibid.*). To establish this credit system, the responsible entities will sign a letter of consent prior to the start or participation in the project (Article 6). Of course, project participants, evaluation experts, and other individuals will also be part of this credit record system, and various discreditable acts, from so-called FFP to financial and contractual irregularities to the provision of false information, will be subject to regulation (Article 8).

Notably, this database of discreditable acts will be established within the National Science and Technology Information System. These records will be maintained with the name of the responsible entity, a unified social credit code, and associated projects (Article 11). The responsible entity on record will be temporarily or permanently ineligible to apply for national science and technology programs and projects, and to participate in implementation and management activities (Article 12). In addition, the database will be used as a basis for project planning, selection of evaluation experts, assessment of indirect costs, use of surplus funds, and so on, and institutions with a high incidence of misconduct will be the focus of supervision management (*Ibid.*). The strictest measure may be the following: “Based on the temporary implementation of these regulations, after gathering experiences, a cross-department collaborative system will be developed, coordination with other social credit record systems will be strengthened, and a unified government credit system and management system for scientific research will be created” (Article 15). Although these regulations are considered provisional and are subject to revision upon implementation, the intention seems to be for government departments to work together to coordinate social credit record systems beyond scientific research.

The strongest measure that extends these 2016 provisional regulations, namely the above-mentioned May 30,

399 Provisional Regulations on Recording Serious Discreditable Acts in the National Science and Technology Plan (Special Projects, Funds, etc.), Current Status and Prospects of China’s Science and Technology Policy, JST China Center for Comprehensive Research Exchange, p. 71, https://spc.jst.go.jp/investigation/downloads/r_2017_03.pdf

2018, Central Office of the Communist Party of China and Central Office of the State Council "Opinions on further strengthening credit building in scientific research." The content of the opinions is described in section 6.1.3 and will not be repeated here. With regard to coordination with social credit systems, the guidelines state that "joint disciplinary action will be taken, and various reviews and evaluations of project applications, appointments, employment, and so on, will be linked to credit status, which will be an important reference for administrative approval, public procurement, priority evaluation, financial assistance, funding grade evaluation, tax credit evaluation, and so on." In other words, the aforementioned provisional regulations were further developed to be used as a reference for credit evaluation in administrative procedures, finance, tax payment, and other aspects of social life. Thereafter, a 2018 notice[400] stated that control over personnel, finances, and materials by researchers will be established on the basis of sufficient credit, and those who commit serious violations of credit requirements will be subject to lifelong pursuit and joint supervision measures. This is a strict measure for researchers, who are forced to consider that even the slightest involvement in these problems will cause difficulties not only in their research activities, but in their social life.

Now, let us return to the measures for research integrity in the United States. Measures related to research integrity in the United States are set forth in Title 42 of the CFR, Parts 50 and 93, of the Department of Health and Human Services. In evaluating China's measures, it would be interesting to compare China's definition of research misconduct, prevention measures, and misconduct identification and decision-making procedures from the perspective of transparency, integrity, and so on. However, we will not do so in this report, focusing instead on comparing the administrative measures taken when research misconduct is identified.

These administrative measures are set forth as follows in Section 93.407 of the above-mentioned Title 42 of the CFR, Parts 50 and 93. The primary measures taken by the Public Health Service (PHS) are: ① Clarification, correction, and retraction of research reports; ② Issuance of letters of reprimand; ③ Special clarification of compliance with PHS grant and other application regulations; ④ Suspension or termination of PHS grants and other grants; ⑤ Restriction of certain activities or expenditures for PHS grants in progress; ⑥ Special review of PHS financial support requests; ⑦ Imposition of supervision on PHS grants and other grants; ⑧ Certification of attribution and authenticity for all PHS support requests; ⑨ Prohibition of participation in PHS advisory functions; ⑩ Adverse personnel action when the person involved is a Federal employee; ⑪ Request for the return of PHS funds in connection with misconduct depending on other issues related to research integrity (these measures are summarized on the Office of Research Integrity [ORI] website above). In addition to the above, any other criminal activity such as embezzlement or fraud would of course fall outside the scope of these administrative measures. If any of the above forms of misconduct are identified, the individual or organization will be ineligible for all federal government contracts, subcontracts, or certain financial and non-financial assistance/benefits in the United States and will be listed on the Excluded Parties List System (EPLS)[401, 402] Incidentally, although they will not be quoted here, the measures taken against research misconduct in Japan include suspension of research funding for both researchers and research institutions, restitution of research funds, and restrictions on eligibility for competitive funds. There are some areas

400 See paragraph 4 of the July 18, 2018 "Notice of the State Council on measures to optimize scientific research management and enhance scientific research performance" (State Council [2018] No. 25).

401 This system is operated as a counterterrorism, anti-money laundering, and other sanction system by the U.S. federal government and is managed by the U.S. Department of Treasury and Office of Foreign Assets Control (OFAC). https://www.visualofac.com/regulations/excluded-parties-list-system/ (accessed September 4, 2021)

402 https://ori.hhs.gov/administrative-actions (accessed September 4, 2021)

where the accountability system of research institutions may come into question, and under certain conditions, the amount of indirect costs may be reduced, and the allocation of competitive funds itself may be suspended.

In comparison to the measures mentioned thus far, those of China, described above, are too focused on reward and punishment, and on punishing individuals to make an example for others. Moreover, the fact that these measures are not limited to the world of scientific research is extremely punitive. This could possibly mean that the strengthening of control on society at large, such as anti-corruption measures and information control, is also extending to the research environment[403]. The prevention of research misconduct is an indispensable measure to ensure trust in science. However, we should be deeply aware that the fundamental ideology of the political and social system is involved in determining the scope of security measures.

403 Fukuda Naoyuki, "China's AI superpower from the inside—the forefront of the technology hegemony war with the United States," Asahi Shinsho, April 30, 2021, p. 82: "In China, there is a system called personnel management system, in which each citizen's life history, awards, and punishments are recorded and managed by the government. It is said that family registers, family relationships, grades, work performance, and even political attitudes and ideologies are evaluated and recorded in detail."

Conclusion: The Paths of the Policies and Measures Taken by the Chinese Government for Strengthening Basic Research and Improving Research Managements

The basic reforms introduced since the advent of the Xi Jinping administration in China, including those relating to scientific and technological innovation, are all condensed in the decisions of the Third Plenary Session[404]. As mentioned above, the CPC has issued a series of opinions on basic research promotion and scientific research management reform. In line with these opinions, local governments at all levels, universities, CAS, and other scientific research institutions have been pursuing their own independent reforms in a cascade-like progression. Thus far, we have examined these trends. Now, we will summarize them and offer our views on the matter as people who are involved in research. It should be noted that these views do not represent the official position of JST.

First of all, with regard to basic research promotion, we agree with the recognition that the Party has been strongly aware of the lack of originality in the promotion of basic research and has firmly expressed its intention to strengthen basic research based on exploratory free ideas. However, in successive opinions and Reports on the Work of the Government, the promotion of basic research has always included "applied basic research," which requires a strong awareness of national demands and important socioeconomic issues. The documents produced by the Communist Party have been gathered and carefully composed based on the history and context of the Party's leadership. Unsurprisingly, almost all of the relevant documents repeatedly, consistently, and strongly encourage "application-oriented basic research." In a certain sense, it is no exaggeration to say that this approach is being forced on researchers. As a result, many researchers involved in basic research will aim for basic research with "applications" in mind. The goal is to "achieve a virtuous cycle of competition from the point of entry to the point of exit[405]." This will lead people to behave in certain ways, based on the principle of behavior defined by Masuo Chisako: "In China (...), people are always eager to find out 'where the tide is turning' under the top management and try to ride that tide at any cost[406]."

Of course, this is not to say that the concept of "applied basic research" does not exist. Nor does this mean that China's emphasis on applied basic research will produce no results. Nor is it a blanket rejection of State involvement. However, the choice to manage research under the principle of the "organic unification of the role of the market and the role of the government" is questionable[407].

Needless to say, research does not follow a linear model. Rather, it develops in a spiral fashion to produce

404 The Third Plenary Session of the CPC Central Committee is one of the seven sessions held during the Communist Party Congress, usually held every five years. The Third Plenary Session covers economic management policies. For more information on the decisions made at the Third Plenary Session, see "The Direction of China's Structural Reforms as Understood from the Third Plenary Session: Shifting to 'Small Government' through a Review of Authority," (Sano Junya, Senior Research Fellow, Research Division, Japan Research Institute) and others.

405 From the results of a survey commissioned to Tepia Corporation Japan.

406 Masuo Chisako, "Principles of Chinese Behavior," Chuokoron Shinsho, 25, 2019, pp. 79-80

407 Chinese officials should learn to "correctly use both the "invisible hand" and the "visible hand," Main points of President Xi Jinping's speech when presiding over the 15th group study session of the Political Bureau of the 18th CPC Central Committee, May 26, 2014.

achievements under open access, with a mix of basic research, applied research, and experimental development. The problem is the strong promotion of applied basic research within the framework of basic research. There is a need to emphasize the fundamental structure in which huge amounts of money are invested in basic research, and a chain of activities leading to innovation is built upon this broad foundation and base. The most obvious example of this is the United States. In the words of Takizawa Minako, "DARPA can only exist because there is valuable basic research that can be used as a reference (emphasis ours) by PMs (project managers). To that end, high-value basic research must be secured through long-term, reliable investment in basic research as a seedbed, so-called 'high-trust funding.' That is the case, for example, with the NIH in the U.S. health sector[408]."

Even if the ratio of basic research in China, which by definition includes "applied basic research," is increased to 8% or more of total R&D investment, as targeted, this will not necessarily lead to the promotion of free pure basic research. On the contrary, the amount of investment in basic research is not really known. Countries such as the U.S., where huge amounts of money are invested in the NSF and NIH over the long term through funding institutions, have a high ratio of so-called external funding and relatively little institutional support, which makes the system very straightforward. We should keep in mind that in Japan and Europe, it is generally difficult to distinguish between research funded through institutional subsidies and to determine the amount of investment in basic research. Nor is it easy to ascertain the number of researchers engaged in basic research, as we have tried to do in this report. These aspects require more in-depth study in the future.

The terms "free ideas" and "free exploratory research" appear frequently in policy documents such as the Party's guiding opinions. They are enshrined in both the Constitution and the Progress of Science and Technology Law. This is not enough to dispel many experts' concern that the concept of freedom is not being used in its original sense and, therefore, will not form the intellectual foundation for innovation. This point has already been made by Kajitani: "To summarize these mainstream arguments, China lacks free speech, property rights, and a legal system that guarantees the sustainability of innovation, especially intellectual property rights." We do not intend to go so far as to discuss "civil liberties" here. However, it would be very interesting to see if there is discourse that relates the weight of the word "freedom" to the state of freedom in basic research in China. The Party is not immune to "path dependence," and under its leadership, science and technology promotion centered on basic research in the true sense of the word, in which ideas can flow freely, may be an impossible choice. The problem of freedom is also connected to the issue of the "seven banned topics[409]," and considering its association with the "removal of freedom of thought from the university charter[410]," as seen at Fudan University, the meaning of freedom itself is unlikely to be discussed in depth. As Hirano Satoshi argues, drawing on the Confucian view of order, "Free ingenuity, when taken to the extreme, is even an enemy of the vertical order[411]." The question is whether the Party's guidance on "New Direction - Freedom in Science" in the 14th Five-Year Plan will lead to the recognition that broad, diverse, and free basic research will realize innovation.

408 Takizawa Minako, *ibid.*

409 On May 11, 2013, the Hong Kong newspaper Ming Pao reported that the Chinese Communist Party had banned university faculty from discussing seven topics with students. The topics are "universal values, freedom of the press, civil society, civil rights, historical errors committed by the Party, the privileged elite class, and judicial independence." (https://www.recordchina.co.jp/b72245-s0-c10-d0000.html accessed March 14, 2022)

410 Funamori Miho, "Fudan University Removes 'Freedom of Thought' Text from University Charter," December 21, 2019, National Institute of Informatics Research Center for Open Science, https://rcos.nii.ac.jp/miho/2019/12/20191221/ (accessed March 21, 2022).

411 Hirano Satoshi, "The history of 'anti-Japanese' China's civilization," Chikuma Shinsho 1080, p. 82.

If this can be accomplished, China's innovation will make further progress, However, this is a double-edged sword, which is also a problem for the Party, and the current situation is one which just barely offers the "freedom" that leads to innovation.

On the other hand, survey results indicate that the Xi Jinping administration's reforms of scientific research management and funding institutions have been fairly well received by researchers. Researchers have confidence in the fact that evaluation is based on scientific value. This is evidence that dissatisfaction with past issues such as personal evaluations is now being resolved. However, there are strong calls for the clarification and diversification of evaluation criteria. Although there is no room here to discuss how far the diversification should be extended, defining the criteria itself is actually not that easy. Many researchers, not only in China, are seeking clarification of these evaluation criteria. In fact, the mechanism of peer review is centered around the fact that the experts involved are responsible for scientific evaluation. However, the strong demands for clarification of evaluation criteria in China may indicate how low the level of trust in peer evaluation remains. According to the results of a survey commissioned to Japan TEPIA Corporation, one of the respondents expressed the following opinion: "In project reviews, methods such as 'peer review,' 'project evaluation,' and 'expert voting' do not fundamentally remove risks related to subjectivity and human relationships. This evaluation system not only fails to evaluate projects scientifically but also diminishes the quality of scientific research results, cannot support basic research projects requiring long-term and stable support to produce results, and may even lead to the expansion of projects pursuing short-term benefits." In other words, peer evaluation itself is not institutionally mature, the awareness and sense of responsibility of participating researchers may not be widespread, and reviewers may be influenced by a culture that values so-called "relationships." The guiding opinions introduced above also state that "international peer review" should be explored. However, the responses to the questionnaire survey suggest that international peer review is still not being pursued in a manner that would meet the expectations of researchers.

As mentioned above, for peer review to function as intended, the process by which an applicant's innovative and unpublished project is reviewed by researchers with sufficient expertise in an extremely advanced field mobilizing their latest knowledge should be the very activity that pushes the frontiers of the scientific field in question. Peer review should be a creative intellectual process that goes beyond simply grading an applicant's project. Peer review is a commitment that requires dedication from participating experts, applicants, and program managers alike, as well as an opportunity for the selected experts to be exposed to the new advanced knowledge developed in the proposals, and to disclose their own advanced knowledge. This is what peer review is all about, and it is a driving force in science. Of course, a perfect system is difficult to achieve. However, in spite of many challenges, the significance of the peer review method has been demonstrated in the experience of Europe and the United States. The lack of trust in peer evaluation in China indicates that researchers have not fully developed an awareness of the power of peer review to pioneer the cutting edge of scientific fields. Although there are many researchers returning from the U.S. and other countries, there are still few who properly embody these countries' scientific culture of peer review in China. Perhaps, this is another attempt to find a method with "Chinese characteristics" that are emphasized but not clearly defined. Chinese researchers are concerned about their dependence on the U.S. and other countries for the training of young researchers, and they believe that at this rate, this important opportunity for scientific advancement will not be fully utilized in the future.

In connection with evaluation, some have proposed a system where judgments are left to the market. Although this is not mentioned in detail, the above calls for clarification of evaluation criteria express the expectation that the market, as such, will make a decisive judgment. This may be a reaction against personal evaluation, or a demand related to the current unclear evaluation criteria. However, it can also be seen as a misguided and excessive expectation of the function of the market. In contrast, basic researchers in Japan, the U.S., and Europe are not often directly aware of the market in their research evaluation. In a society where the State is allowed to intervene in the market in an opaque manner to a certain extent, and where such intervention itself rationally constitutes a system, we cannot help but wonder how confident one can be in the opinion that research evaluation should be left to the market. The idea that the market makes judgments presupposes the existence of human beings who act of their own free will, and only when such judgments are made fairly can the market be a reliable evaluation criterion. This is not an issue that can be resolved by simply invoking the term “market” and ignoring the rest. The solution to the problem itself seems to create a situation in which further problems will arise. Perhaps, an elaborate system that is beyond our imagination is currently being conceived.

A similar situation exists for the future of journals. China is strengthening its training measures to improve the level of its domestic journals. The distinction between Chinese-language journals and English-language journals originating in China is a delicate issue. However, in both of these cases, Chinese journals’ new editing method is one in which the editors invite outstanding researchers to submit papers. Aside from the global problem of major journals being monopolized by a limited number of publishers, this is quite different from the way researchers in Japan, the U.S., and Europe select the most appropriate journal themselves and submit their papers for evaluation by the journal’s experts. Although “Chinese characteristics” are currently being advocated in many ways, this Chinese journal editing method breaks with the current global standard, which tends to judge the quality of journals and the quality of papers published in those journals based on their impact factor. Instead, this system judges the quality of papers by its own standards and methods, demonstrating China’s intention to bring the Chinese approach to a more prominent level and to lead the way in this type of evaluation. In other words, this is another instance of China attempting to gain hegemony. In fact, the policy of requiring one third of papers to be submitted to Chinese-language journals may lead to a decrease in the number of Chinese papers published in SCI-indexed journals. Therefore, the number of Chinese papers may actually decrease, and the number of citations may not rise as steadily as in the past. In such a case, China may be able to properly explain its own standards and methods and may also clarify the content and meaning of its evaluation system to domestic researchers. Therefore, in the next few years, the evaluation of China’s global ranking in indicators such as number of papers, citations, research funds, and number of researchers will probably become meaningless. Japan, the United States, and Europe will need to understand the significance of the Chinese evaluation system to be able to accurately gauge its relationship to science and technology innovation capabilities.

Various reforms in funding institutions, such as the abolition of the “four only” standard and the introduction of the “lump-sum” system, seem to have had a positive impact on researchers’ performance, especially contributing to increased opportunities for young researchers to actively take on new challenges. One of the characteristics of China is that local governments, universities and scientific research institutions on each level freely consider and implement specific measures based on the principles of central government policies. However, the consistent response to CAS Vice President Zhang Tao’s statement that “during the 14th Five-Year Plan period, more than 50% of the new directors and deputy directors of institutes will, in principle, be under 40 years old” is typical of China. Such a measure would not be easily accepted in Japan, the U.S., and Europe. Therefore, although some of its choices may be bold, and some of its policies may not be feasible from the perspective of Japan, the U.S., and Europe, China’s strong ability to apply, develop, and implement discoveries in the field, combined with the size of its market and its ability to accept innovation, is a force that has supported the country's overall development to date. In the reforms of funding institutions that have taken place during this period, the way in which R&D funding, such as institutional subsidies and competitive funding, is provided has stimulated the power of the research field to the maximum extent possible and has been a powerful factor in bringing about structural change. For example, in the use of indirect costs, the structural relationship between financial support for the entire institution and financial support for special projects is effectively reconciled by allowing the use of indirect costs, rather than institutional subsidies, to cover incentive spending. Although this is a controversial issue in Japan and Europe due to the inability to organize this relationship, it would be worthwhile to refer widely to the methods used in the United States, China, and other countries that have implemented this approach. In light of our initial statement that the forces that drive research itself have something in common regardless of the political, economic, or social system, the content of these Chinese reform policies should be very illuminating.

If China is to lead the world in scientific and technological innovation in the future, one of the most important challenges will be human resources. Some Chinese researchers are concerned that the intensifying conflict between the U.S. and China will affect the exchange of foreign students and researchers to some extent, and that China will not be able to use the West as a place to foster young researchers as it has in the past. Even considering the impact of the COVID-19 pandemic, the decline in the number of researchers traveling to the United States over the past few years hints at what the future may hold. Some U.S. researchers are concerned that U.S. economic security policies and research integrity measures will adversely affect the ability of the U.S. to attract foreign students and researchers and impede the free circulation of knowledge[412].

In this context, it is extremely interesting to note that China is taking measures to attract prominent researchers from around the world. The documents outlined above mention institutions such as a "global scientific research fund," "international science and technology organizations within the country[413]," and "global key talent centers[414]," which have yet to be defined in concrete terms. These are probably measures to gather Chinese wisdom, invite foreign talent, and promote exchange in response to countries that are considering new approaches to international collaboration with China through the Quad, Five Eyes, and other organizations. China may develop an international collaboration framework called the Alliance of International Science Organizations (ANSO)[415], which was officially created in November 2018 to contribute to the Belt and Road Initiative. As stated by U.S. academic societies, among others, the idea that the international circulation of knowledge not only in the U.S. but also in other countries is the driving force for the development of science and technology should be maintained in principle. Yet, the structures of U.S. funding agencies such as the NIH, NSF, and DARPA, as well as the policies of the European Commission, are building a framework of support for foreign researchers by establishing systems to eliminate the impact of nations that exert

412 According to the report "Impact of US Research Security Policies" introduced by JST Beijing Office Director Chayama, "About one fifth of the respondents withdrew (gave up) cooperation with foreign countries because of the current research security guidelines." 16% percent withdrew individually (at their own discretion), and 9% withdrew at the behest of others. Examples include withdrawing cooperation with a postdoctoral fellow and not writing a letter of recommendation for a student to work in China. At least 40% of foreign early career professionals and 45% of graduate students say that current U.S. policies have a negative impact on their ability to remain in the U.S. long-term. https://www.aps.org/newsroom/pressreleases/upload/APS-Impact-of-Research-Security-Report.pdf (accessed March 21, 2022)

413 Proposed in the 14th Five-Year Plan for National Economic and Social Development (2021-2025)

414 Raised in Premier Li Keqiang's Report on the Work of the Government at the March 2022 National People's Congress

415 http://www.anso.org.cn/about/history/ (accessed March 13, 2022)

undue influence and threaten the scientific and technological initiative of other countries. Although these efforts are not intended to exclude certain races or ethnicities, they are creating a climate where researchers from nations that are deemed to exert undue influence are increasingly impacted and excluded. It is appropriate to assume that China is attempting to counteract this situation. Many of the researchers who are leading science and technology innovation in China are returnees. However, it is very important not only to look at the future of the personnel invitation and exchange program, but also to consider the current and future international researcher networks of China-based researchers, to build a database of leading researchers in key fields, and to monitor the transitions of Chinese researchers' international networks over the long term. The "Thousand Talents Program" and other overseas human resource programs have already been integrated into individual foreign researcher recruitment policies that take into account various preferential measures and are considered to be part of a rather complicated system in actuality. However, close attention should be paid to how measures such as the "World Science and Technology Fund" described above will be adapted to the new phase.

When studying China's science and technology, we should collect relevant information from China on various aspects of science and technology and R&D and analyze and evaluate these aspects to explore options for pursuing Japan's national interests in cooperation with friendly countries, while also referring to the views of countries with diverse value systems. We believe that, by analyzing and evaluating the situation from a different perspective than previous studies, which focused on quantitative development, we may be able to find ways to further shape the economic and security policies of Japan, Europe, and the United States. We believe that such very different analyses and evaluations may also help to identify more concrete measures for economic and security policies in Japan, Europe, and the United States. We hope that this research study will provide an opportunity to do so. In future international collaboration with China in the field of basic research, it must be recognized that the country's basic research is strongly oriented toward application, based on the major premise of military-civilian integration. We hope that this research study will provide an opportunity to do so.

Lastly, what we have described in this report can be seen as a kind of advice to China. If China, for example, fully understands the meaning of the points made in this report and takes it as a reference, and if it promotes basic research based on original free ideas as we understand them, it will be able to promote research with originality leading to innovation.

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