DOI 10.15302/J-SSCAE-2021.06.019

Strengthening National Strategic Science and Technology Strength to Serve Economic Development

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Abstract: Establishing a modern economic system is a strategic goal for economic prosperity in China. A strong national strategy for science and technology is required to provide strategic support, pioneering ideas, and sustained input to serve as the primary driver of the process. In this study, we first clarify the significance of strengthening national strategic science and technology capabilities to facilitate economic development. Next, we propose an overall approach for improving national strategic science and technology strength by developing an innovation-driven and coordinated modern industrial system. This is aimed at reshaping the landscape of global industrial competition in the new era of scientific and technological revolution and industrial transformation and determining the role that China plays in the global economic arena. We then investigate major pathways and specific measures to enhance national strategic science and technology strength with regard to the following three aspects: (1) improving the quality of actors conducting strategic scientific and technological research, (2) building an industrial scientific and technological innovation network, and (3) playing a strategic support role. Finally, we provide policy recommendations on aspects such as (1) supporting industrial innovation by implementing different strategies, (2) training the personnel embarking on industrial, scientific, and technological endeavors, (3) optimizing the environment for industrial innovation, (4) strengthening financial capital market support, and (5) developing a professional scientific and technological service system.

Keywords: economic development; national strategic science and technology strength; modern industrial system

1 Introduction

As outlined in the *14th Five-Year Plan (2021–2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 of the People's Republic of China*, the establishment of a modern economic system is the guiding principle and major goal of embarking on the journey of building a socialist modern country. As President Xi Jinping highlighted at the third group study session of the Political Bureau of the Communist Party of China (CPC) Central Committee, it is imperative to accelerate the pace of implementation of the innovation-driven development strategy, strengthen strategic support in the modern economic system, enhance

Received date: October 10, 2021**; Revised date:** November 20, 2021

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Funding program: CAE Advisory Project "Research on the Construction of National Strategic Science and Technology Forces Facing the Economy Arena" (2021-HZ-13); National Social Science Foundation Youth Project (17CTQ023); Chinese Academy of Sciences Youth Innovation Promotion Association Project (2018464); Gansu Provincial Key Talent Project (E1390905)

Chinese version: Strategic Study of CAE 2021, 23(6): 120–127

Cited item: Bai Guangzu et al. Strengthening National Strategic Science and Technology Strength to Serve Economic Development. *Strategic Study of CAE*, https://doi.org/10.15302/J-SSCAE-2021.06.019

national strategic scientific and technological forces, and advocate the in-depth integration of science and technology innovation into the development of the economy and society. The periodic shift of the global scientific center also implies that since the second industrial revolution in the mid-19th century, a positive and virtuous cycle of science, technology, and economy must be developed for a country to become a strong force in global science and technology and a major center for science [1].

The contest for world leadership in science and technology is, in essence, a competition of national strategic scientific and technological strength. Under the guidance of national strategic goals, the aim is to achieve major breakthroughs in core technologies to influence current and future national interests, and effect considerable advances in unexplored domains as well as scientific and technological issues that may constrain national development and the security landscape. The enhancement of national scientific and technological strength to support the building of a modernized innovation-driven economic system with capable enterprises and well-developed industries and realize China's position as a powerful economy is worth consideration.

2 Significance of enhancing national strategic scientific and technological forces to serve economic objectives

2.1 Satisfying the underlying demand for coordinating both domestic and international needs

The world is witnessing accelerating changes that have not been observed in the past century, confronted by a sluggish global economy, rising unilateralism, and protectionism that runs counter to globalization. The increasing uncertainty and instability will reshape global industrial and supply chains. Therefore, the underlying demands for safeguarding economic security, shaping advantages in global competition, and gaining a greater say in the global industrial system can be met by enhancing national strategic scientific and technological forces to serve economic objectives, ensuring the security of industrial, supply, and technological chains, supporting the self-reliance and self-improvement of a modern economic system, and maintaining a high level of opening up. China is now developing a modern economic system at an accelerated pace in its bid to build a strong socialist and modern country. At this stage of high-quality development, the radical solution for shifting the mode of development, optimizing the economic structure, and converting economic drivers lies in playing a high-level leading and strategic supporting role in technological innovation, with the primary incentive being the consolidation of national strategic scientific and technological forces [2]. After years of catching up, China's industrial technology will face problems such as increased uncertainty, trial-and-error costs, and difficulty in building an innovative ecological system; therefore, there is an urgent need for developing national strategic scientific and technological strength to meet the underlying demand for consolidating the technological foundations of a modern economic system that can lead the emerging global industry and seize the initiative in designing future economic development strategies.

2.2 Satisfying the requirement for improving the overall performance of national innovation system

In China, the national innovation system has been established and developed through its transition from a planned to a socialist market economy [3]. However, with regard to the development of innovation entities, the deployment of innovation resources, optimization of innovation environment, and formulation of innovation policies, more emphasis has been attached to the national security innovation system and national research and experiment system with research institutes and universities as entities. Therefore, there has been a lag in the development of both national industrial innovation and regional technological innovation systems with enterprises as entities. It is therefore imperative to improve the national innovation system and enhance national strategic scientific and technological forces to serve economic objectives, promote mutual support between scientific and technological innovation and the real economy, and create a positive cycle for boosting the overall performance of the national innovation system. On one hand, efforts in such fields as key industrial generic, frontier, modern engineering, green low-carbon, and disruptive technologies that require huge investments and span a long period with slow progress should be prioritized to develop a supply system for basic industrial technology, advance in-depth integration between the innovation and industrial chains, and strengthen the leading role of the national innovation system in low-carbon and high-quality green development. On the other hand, national strategic scientific and technological forces should be leveraged to build and develop a cross-field, highly coordinated, and highly intensive industrial innovation base and regional innovation arena, optimize the spatial layout and clustering effect of innovation resources, and attach importance to coordinated innovation and knowledge spillover to develop progressive connectivity and an in-depth layout, wherein an internal cycle serves as strategic support and a dual cycle serves as

DOI 10.15302/J-SSCAE-2021.06.019

the core node. Doing so will enhance the strategic supporting role of the national innovation system for creating a new development landscape.

2.3 Satisfying he internal requirement for improving national economic governance capacity

With the fading of the Washington Consensus, effective market integration and joint efforts with the government to propel the development of an industrial economy have emerged as the new consensus for most countries. On one hand, through effective market competition in the modern economic system, factor resources are allocated efficiently to industries enjoying a promising market and innovation is incentivized. On the other hand, with economic management and macro control of market actors, as well as the coordination of entities on issues concerning major interests in overall development, market failure is addressed, providing guidance for the upgradation of industrial structure to ensure the supply of basic research in enterprises. Currently, China possesses outsized consumer and financial markets, necessitating the enhancement of national strategic scientific and technological forces to serve economic objectives, thereby enabling key industries to generate generic technology, offering prescient directions for innovation, and facilitating the coordination and control of major industrial science and technology resources. Under the socialist market economy, efforts should be made to accelerate a new system concentrating nationwide efforts and resources on making major breakthroughs in core technologies and key fields, jointly developing a platform for basic technologies and open innovation in strategic industries, fostering interactive cycles between the driving forces of technology, market, and capital, and pushing for rapid growth of economies of scale for industries.

3 Overall approach and development pathways for enhancing national strategic scientific and technological forces to serve economic objectives

The modern economic system comprises the modern industrial system and its operating mechanisms; the management system must correspond to efforts to develop China into a great modern socialist country [4], aiming to drive economic development through quality, efficiency, and dynamic revolutions. The global development journey since the 18th century clearly indicates that the restructuring of the economic system, rise of modernization, and adjustment of the global economic landscape are primarily driven by industrial transformation and technological revolution. Shifts in industry, science, and technology represent the momentum underlying the restructuring of production relations and the evolution of superstructure, which is repeated through the rise and fall of nations and civilizations [5]. The industrial system serves as the physical foundation for the construction of a modern economic system, whereas scientific and technological innovation is the primary driver of its development. The improvement of an innovation-driven and coordinated industrial system conforms to the historical time when the new round of technological revolution meets the transition of development in China. Its essential purpose is building a modern economic system guided by new development and providing a major arena for national scientific and technological strength to play its role in economic development.

3.1 Overall approach

The key to enhancing national strategic scientific and technological strength to serve economic objectives lies in concentrating on the goals of realizing high levels of self-reliance and self-improvement in science and technology in the modern industrial system; deploying and gathering all components of national strategic scientific and technological strength to create advantages as entities; forming a systematic layout and playing a decisive role in reshaping the global industrial competition landscape in the new science and technology revolution; and supporting China’s role in the international economy. Its objectives are to systematically enhance the capacity of science and technology to support the upgradation of the industrial foundation and modernization of the industrial chain, consolidate the strength of innovation in shaping new advantages in international competition, continuously enforce the motivation of knowledge factors in driving the high-quality development of the real economy, and strive to cultivate the potential of independent research and development (R&D) activities to push the manufacturing industry toward the middle and high ends of the global value chain. The key is to foster a group of entities with national strategic scientific and technological strength that represent national goals, serve national needs, and reflect national capacities centered on a modern industrial system; build a national industrial science and technology innovation network with platforms for major science and technology innovations and new innovation organizations as links; and focus on the role of national strategic scientific and technological strength to provide strategic support, pioneering ideas, and sustained inputs. This will serve as the primary driver through the implementation of strategic

scientific and technological plans.

With regard to strengthening entities conducting science and technology activities, a group of national laboratories will be established in major industrial innovation fields to guide national strategic scientific and technological forces. An array of leading science and technology enterprises with outstanding core technologies and strong innovation capacities will be fostered, and national key laboratories will be developed within enterprises to make them central to national strategic scientific and technological forces and the economy.

It is essential to establish an innovation network by optimizing national centers for engineering research and technology innovation, setting up international, national, and regional science and technology centers, and exploring the possibility of new innovation organizations such as innovation consortiums and industrial innovation councils as contact organizations. The creation of a national industrial science and technology innovation network led by leading science and technology enterprises, supported by research institutes and universities, is necessary to develop a systematic and regular layout of national scientific and technological forces in the economy.

Regarding the strategic role, the government's role as the organizer of major science and technology innovation activities should be emphasized. Strategic scientific and technological programs and major science, technology, and engineering projects should be implemented. National strategic scientific and technological forces should be guided to target the national strategic demands of industries and achieve breakthroughs in core technologies in key fields to provide fundamental support for a modern industrial system and drive development, thereby ensuring that national strategic scientific and technological forces play its role in the economy.

3.2 Development pathways

3.2.1 Enhancing the role of leading science and technology enterprises as new entities and strengthening the innovation capacity of strategic scientific and technological forces

Leading science and technology enterprises are core entities that conduct innovation activities and implement basic strategies in the economy. They have good knowledge of markets and are experienced in combining innovation and organizing platforms. They are the innovative entities, and driven by the need for adapting to the market demand structure, their innovation capabilities can be promoted.

Enterprises should be encouraged to play their roles in terms of raising practical problems and assessing performance, so as to have a greater say in major national science and technology layout and promote the conversion rate of major scientific and technological advances. By focusing on the market, leading science and technology enterprises at the forefront of industries can precisely detect the demand for innovation and quickly capture positive feedback from the consumer market. Furthermore, by conducting innovation activities, enterprises can recognize bottleneck problems that constrain industrial technology and verify scientific and technological advances and trail iteration. Enterprises should play their role in identifying problems effectively. Permanent channels and mechanisms of presenting practical industrial generic problems and addressing national important strategic demands in real terms should be improved to break the established barriers within enterprises, industries, and the research community. A channel needs to be created to upgrade the technical demands of leading science and technology enterprises to the list of key industrial generic problems and major strategic demands of national industries. Enterprises should effectively assess their performance in a market economy. The principal roles of enterprises include examination, achievement transformation, and value assessment for major science and technology tasks, narrowing the time gap between scientific breakthroughs, technological development, and industrial application.

Enterprises should be supported to improve the central R&D system and establish an innovation ecosystem. A central R&D system with research institutes as representatives should be developed, which is not only the common choice for both domestic and foreign large enterprises to enter the innovation stage but also a general trend for science and technology organizations in enterprises under an open and innovative environment. Compared to the single, linear, and dispersed conventional R&D system for technologies, the central R&D system is capable of integrating research with internal and external resources, analyzing technology information, managing intellectual property, undertaking two-way technical transfer and merging with high-tech enterprises, docking capital, incubating start-ups, incentivizing talents through multiple dimensions, and managing the lifecycle of teams. As the core entities and dominant forces, central institutes and similar organizations serve as important carriers and platforms for enterprises to participate in the development of national strategic science and technology competencies. At a higher level, they can undertake national development strategies for major industries and science and technology projects and tasks, building key infrastructure for the latter, and serve as important innovation platforms for national science and technology. Within enterprises, they can share technical advances, develop core technologies in fields, focus on

DOI 10.15302/J-SSCAE-2021.06.019

global high-level innovation resources, forecast future industrial development, formulate innovative development plans, cultivate emerging entities for the industry deploying frontier and disruptive technologies, and create an open and inclusive "pond" innovation system in which innovation factors grow and innovation entities collaborate effectively. All these efforts can support enterprises in continuously enhancing their innovation capacity and maintaining their first-mover advantage in external competition.

High-standard national key laboratories should be established for enterprises to develop national strategic scientific and technological forces. This is an important component for technical innovation in a national system, as well as an essential platform for leading science and technology enterprises to develop innovation capacity and play leading roles in industry. Currently, because of the differences regarding properties of enterprises, knowledge, and management levels, some laboratories face problems such as an uneven supporting channel for input, unsound assessment and incentive mechanisms, an unstable high-end talent pool, and an insignificant application of scientific and technological advances, which constrain their role as national strategic scientific and technological forces. In future development, it is first crucial that the role of key laboratories for enterprises as "relatively independent science and research entities" should be made clear. The operating mechanism should require that they conduct independent management assessments, rather than relying on specific organizations. An evaluation mechanism in which performance is tied to output should also be established to support laboratories with requisite conditions to implement individual management of salaries on a trial basis and explore a more flexible salary incentive system. Second, the evaluation metrics of superior departments on national key laboratories for enterprises should be optimized and further refined to assess R&D investments and application of advances in real terms. Third, stable support, project undertaking, outcome evaluation, and talent flow mechanisms for national key laboratories for enterprises should be improved so that they become the major driving force to promote national strategic scientific and technological forces in the industry.

3.2.2 Creating a new network for national industrial science and technology innovation to strengthen the integration and innovation capacity of strategic scientific and technological forces

A new network for national industrial science and technology innovation with leading science and technology enterprises as nodes, and innovation bases, platforms, and organizations as contacts is the basic structure and regular strategic layout as well as an important component of the national innovation system. The development of key industrial generic technologies, sharing of science and technology resources, and the application of science and technology advances should be prioritized to develop an effective and strong supply system of generic technologies.

The construction of a national science and technology innovation base should be optimized and the core network of industrial science and technology innovation developed. National science and technology innovation bases, such as national centers for engineering research and technology innovation are basic frameworks for developing a national innovation network for industrial science and technology. During the current construction process, problems such as pursuing an R&D process over market results, R&D for new products over breakthroughs on principles, short-term performance over ecological conservation, and application of advances over capacity building should be avoided. Efforts should be made to establish appropriate mechanisms for organizing, implementing, initiating, and withdrawing projects, packaging and distributing tasks, applying scientific and technological advances, and distributing income for enterprises to make major breakthroughs in science and technology and apply scientific and technological advances. Relationships between funders and recipients, decision-makers and performers, executive and technological decision-making, and science and technology and support personnel should be scrutinized. Enterprises should strive to rely on a scientific and technological innovation base to take on a leading role. With the common destiny of shared interests as the foundation and the market mechanism as the bond, they should collaborate with scientific and technological forces in universities and upstream and downstream enterprises. Furthermore, classification and prioritization should be clarified to push for the integrated allocation of projects, bases, talents, and funds in key fields. Channels should be opened up between enterprises and universities to jointly deploy science and technology forces and build and share science and technology resources to develop a framework for industrial science and technology innovation.

National science and technology innovation platforms need to be deployed faster to develop a regional network for industrial science and technology innovation. As important carriers for a high-level and open regional coordinated innovation network, international, national, and regional centers for science and technology innovation should play to their advantages as platforms for large-scale scientific facilities with strengths in terms of geological proximity, a collection of factors, diverse carriers, multiple business forms, and flexible mechanisms, fully covering

the “0-1-100” industrial innovation chain and effectively promoting the spillovers and distribution of knowledge coupled with technical and capital market efficiency. A series of regional networks for industrial science and technology innovation in which multiple innovation entities are coordinated, various innovation factors flow rapidly, and an array of innovative business forms develop vigorously should be progressed and strengthened. Moreover, in line with the regional development strategy, efforts should be accelerated to deploy several national platforms for science and technology innovation, to play to their remarkable advantage in cultivating regional industrial clusters, thereby expanding the industrial innovation network, optimizing the regional industrial structure, and creating new growth points for the economy. This will motivate the joint construction of the regional innovation network between national and regional strategic scientific and technological forces and their integration into the global innovation system. Moreover, interregional cooperation on innovation should be promoted by relying on the natural resource gap for regional innovation factors [6]. The complementary aspects between factor drivers and the regional innovation network should be enhanced.

New organization models for science and technology innovation should be explored and a network with intensive industrial science and technology innovation created. By following the new characteristics and trends of global science and technology reform and industrial transformation, the new organization model should be inspected and practiced during the process of network building for industrial science and technology innovation: (1) Drawing on the experience of the European Innovation Council, an industrial innovation council led by strategic scientists according to different sectors should be set up with members from leading enterprises in the industry, targeted downstream users, and departments responsible for science and technology affairs and superior organization. The council will be responsible for making major breakthroughs on challenging science and technology issues, tackling problems in core technological research that hinder China’s development using an open competition mechanism to select the best candidates to undertake key research projects, providing support for concept verification of disruptive technologies in the early stages, and accelerating the incubation of small- and medium-sized start-ups. (2) Drawing on the experience of the Very Large Scale Integration Semiconductor Project in Japan and the SEMATECH consortium in the United States (US), other enterprises, universities, and upstream suppliers should be called upon to establish an industry–technology research consortium on generic key technologies in the industry and conduct the parallel verification of multiple technology pathways and integration verification with funding from both government and enterprises. (3) Drawing on the experience of national R&D entities in Japan, under the guidance of government, led by enterprises together with research institutes and universities, a research academy on industrial technology, new R&D institutes, industrial innovation alliances, and other innovation consortiums should be established; ownership and operation rights, decision-making and implementation processes, and affairs and technical management should be separated; a clear ownership structure and incentive mechanism and mechanisms for the application of intellectual property, income distribution, project support, and withdrawal should be established. (4) Drawing on the experience of the Industries of the Future Institutes in the US, with the limited liability company as the operation framework, full process integration from basic and applied research to the industrialization of emerging technologies and cooperation and innovation across different disciplines and sectors should be emphasized. (5) Drawing on the experience of National Network for Manufacturing Innovation in the US, a network for manufacturing innovation on industries key to national strategic demands should be created, which should be supported by the government and led by enterprises. A center for manufacturing innovation should be developed to explore the new development mode of “enterprises + consortium,” promoting the application of technological advances in certain fields.

3.2.3 Refining the system of strategic scientific and technological projects to steer the decisive role of strategic scientific and technological forces

With a view to serving the imperative and long-term national demands on the industry, an array major technology projects of strategic significance should be implemented. China should take the lead in deploying national strategic scientific and technological forces to dominate the competition regarding future industrial technologies, effect major breakthroughs in generic bottleneck technologies, and secure disruptive technologies.

Flagship R&D plans for the industry should be launched to take the lead in the future. Based on the experience of the Quantum Flagship Program in the European Union (EU) and the Quantum Leap Flagship Program in Japan, efforts should be made to establish flagship science and technology programs that support long-term, farsighted, high-risk, high-return, cross-field, and large-scale industrial R&D activities in industrial technological fields with outstanding strategic value and great market promise. A systematic roadmap should be developed, in which the prioritized areas, main goals, key challenges, and timeline are outlined. A professional organization should be

DOI 10.15302/J-SSCAE-2021.06.019

established to coordinate management and assess goals. The national strategic scientific and technological forces across multiple sectors, regions, and types can jointly tackle major scientific problems and establish a generic technology supply chain by pooling all resources. The pace of knowledge dissemination should be accelerated and areas of technology application expanded through the innovation consortium for industrial technology. Young prominent talent in science and technology frontiers commensurate with the scale of the field should be nurtured through enhanced international cooperation in multiple disciplines to lay the foundation of next-generation industries that are highly focused on national future development.

Key industrial innovation projects should be launched to generate breakthroughs in terms of crucial bottlenecks. Based on the understanding that "there are unequivocal agreements of capable R&D institutes and high-level experts in the industry on the most imminent and key bottleneck problems constraining the industry," self-cycling should be eliminated. Through mechanisms such as direct entrustment, selecting highly qualified individuals to assume command can support leading science and technology enterprises in taking the lead in implementing problem-oriented national major science and technology projects (hereinafter referred to as "industrial key projects"). By focusing on generic bottleneck technologies, these projects should seek to tackle deterministic problems constrained by multiple goals. Efforts should be made to lead diverse innovation entities and a variety of innovation factors and resources from multiple channels to flow to industrial key projects. High-level research institutes and universities should be encouraged to deeply engage in industrial key projects and assess those undertaken by research teams by the same standards applied in national projects; industrial key projects should be included in the performance evaluation system, considering technical title assessment, performance evaluation, and achievements. Salary, performance assessment, and title promotion mechanisms for researcher teams should be formed to conduct long-term and regular industrial key projects in universities and research institutes. To assess project achievements, review groups must be organized, in which the technical principal from the leading enterprise acts as the group leader and several influential chief engineers of enterprises, business managers from enterprises, industry experts, and personnel from departments in charge of technology serve as members.

The management mechanism of science and technology projects should be sufficiently innovative to identify and cultivate disruptive technologies in the industry. Disruptive technologies can change the current technology paradigm in an unconventional manner, leading to disruptive effects on the mainstream technology, market landscape, and international competition trends of the industry. Given this, disruptive technologies must be considered as highly important in the national system for technology innovation. As the development of disruptive technologies is highly uncertain, the conventional management mode of science and technology plans in terms of planning–guiding–project fails to identify and nurture disruptive technologies. Furthermore, individual enterprises cannot afford the high trial-and-error, opportunity, and time costs. It is therefore imperative to innovate the management mechanism of science and technology projects in aspects such as identifying demand, initiating projects, allocating resources, managing process, and evaluating and assessing performance. Efforts should be made to guide national strategic scientific and technological forces of various types to conduct innovation activities involving disruptive technologies that are at the frontier, highly challenging, and risky, so as to explore technologies that can nurture future industries and lead to more fundamental shifts in economic growth and social development [7]. Key innovation projects involving disruptive technologies should be launched and project coordination systems be explored. As key innovation projects involving disruptive technologies aim to identify the demand in industrial markets, the "seed" of disruptive technologies must be recognized to encourage the verification of bold ideas and support unconventional cross-discipline innovation. Adopting an inclusive approach will encourage talented researchers to conduct innovation-driven and creative original studies through key innovation projects involving disruptive technologies. Project coordinators are responsible for communicating and coordinating the demands and resources of governments, enterprises, markets, and capital. Throughout the process, they must have a say in formulating the technology pathways, selecting research teams, using resources and finances, deciding whether to initiate or withdraw a project, and organizing the implementation of key innovation projects involving disruptive technologies.

4 Creating a sound environment for enhancing national strategic science and technology forces to serve economic objectives

As required by the modern industrial system, the real economy, scientific and technological innovation, modern finance, and human resources should interact in a coordinated manner to realize efficient allocation. China possesses certain advantages such as a large-scale market space in the field of industrial innovation, a relatively complete industrial system, a rich pool of scientific talent, and a relatively mature financial system, leading to advantageous

policy mechanisms in innovation and allocating the production factors required by modern industrial system construction to create a sound environment for enhancing national strategic scientific and technological forces to serve economic objectives.

4.1 Supporting industrial innovation by implementing different strategies

Based on the different stages in global industrial completion landscape, industries in China can be divided into catch-up industries (such as lithography), parallel industries (such as new energy vehicles), and leading industries (such as quantum communications). Based on the differentiated demands of various industries with respect to innovation-driven goals (catch-up industries seek self-reliance, parallel industries seek self-improvement, and leading industries seek to take the lead), organizational patterns of innovation (under socialist market economy conditions, the new national system of making concerted efforts to achieve breakthroughs in core technologies in key fields is suitable for catch-up industries; parallel industries require that the industrial innovation system be vibrant and innovation factors be improved; and leading industries require that the nation establish pilot industrial flagship R&D plans), and the allocation of innovation resources, proper financial, tax, and technological policies should be adopted to support the targeted improvement of national strategic scientific and technological forces.

4.2 Cultivating industrial science and technology talent

High importance must be attached to the cultivation of different talent pools, including strategic scientists, promising and young talent in science and technology, and talent for innovation organizations. The recommendation method and career system should be adopted to select and continuously look out for strategic scientists in the industry and support them to implement a series of major science projects that are foresighted and fundamental. Unconventional assessment systems, including innovation and cross-discipline assessments should be comprehensively applied to support the guiding role of national strategic scientific and technological forces in industrial innovation [8]. With a global vision, introduction and assessment mechanisms for science and technology talent that are more convenient and relevant to the practical needs of industries should be explored. Foreigners holding Foreign Permanent Resident ID cards should be encouraged to fund and run science and enterprises with non-currency assets such as intellectual property and proprietary technologies.

An enabling platform for leading industrial science and technology talent in terms of creating a research environment, nurturing and guiding the market, supporting capital docking, incentivizing the team, and designing professional career should be instituted. In localities with requisite conditions, mutual recognition of research identities among research institutes, colleges, enterprises, and new R&D organizations should be explored so that industrial science and technology talent can be treated as the staff of a public institution and enjoy the same research environment while increasing their income through their involvement in the innovation development of enterprises. Enterprises should be encouraged to jointly develop innovation academies with universities by leveraging factors such as capital, technology, facilities, and platforms. They should conduct “order-based” and “real-scenario” training activities for young science and technology talent. To ensure that the industrial technological innovation presents real outcomes, training such talent in innovation organizations as principle innovators and innovation managers is important for their eventual roles as leaders, organizers, coordinators, and evaluators to tackle major technology problems.

4.3 Fostering the culture of an industrial innovation system

To effectively emphasize the role of national strategic scientific and technological forces in serving economic objectives, a new industrial innovation system and culture that correspond to practical demands should be fostered. The industrial innovation system should be prioritized in the national innovation system as a whole. Efforts should be made to enhance top-level planning and guidance from the national level to the entity-based role of industries, construction of innovation networks, mechanisms of management and operation, forms of resource allocation, and routes of functioning in the industrial innovation system. The engagement and presence of state-owned and private enterprises, especially high-tech private enterprises in the design of national science and technology plans, discussion of guides, project implementation, construction of platforms, and rewards for talent should be enhanced. The bold exploration and pilot demonstration of new R&D models, organizational forms, and business forms in the industrial innovation system should be accelerated. Researchers should be guided to devote themselves to scientific and technological endeavors with a strong sense of mission and responsibility in undertaking major national goals, pride in achieving breakthroughs in core technologies in key fields, and respect in terms of realizing the innovation vision

DOI 10.15302/J-SSCAE-2021.06.019

of the industry [9].

4.4 Enhancing financial capital support

The support system of the capital market for major innovation activities of the industry should be improved. Multiple types of funds should be introduced into the process of industrial technology development and early-stage research. The mechanisms for achieving breakthroughs in major technologies in the real economy, multiple investments in key R&D chains, and yield mechanisms should be upgraded to conduct investment and incubation activities simultaneously and result in a win–win for capital and industry. In some fields, the effective mechanisms for coordinating venture and financial capital to support major R&D activities should be explored. Attempts should be made to return government financial capital through transfers after the operation of enterprises becomes stable, so as to improve the efficiency of capital use. New models of funding and loans, such as pilot investment and loan unions, a pledge of intellectual property, and assessment of technological risks and trade credit should be examined. The financing demands of enterprises at different development stages should be accurately matched. The channels for public listings should be streamlined. Financial regulations for science and technology must be improved and standardized to avoid bubbles in science and technology industries and help domestic science and technology enterprises to prosper with a robust and multi-layer capital market.

4.5 Creating a professional service system for science and technology

By integrating the strength of science and technology information organizations, intellectual property rights organizations, science and technology intermediary mechanisms, and other technology service organizations, high-quality service resources for national strategic scientific and technological forces can be allocated to key processes in the innovation chain. Such processes include managing major science and technology tasks, benchmarking with international advanced levels, selecting an R&D approach, designing an intellectual property strategy, assessing technological value, transferring science and technology advances, incubating start-ups and leading them to maturity, and surveying target market demand. This results in a new service system for science and technology with coordination among multiple entities, integration of various resources, and the inclusion of many scenarios. Under the new paradigm of research, a professional, personalized, and smart service platform for R&D activities should be created to support the national strategic scientific and technological forces to achieve breakthroughs in core technologies in key fields. A science and technology service framework that is driven by data, supported by models, and integrated with artificial intelligence should be developed to realize a cross-disciplinary and multiple-dimensions, “data–modeling–computing–decision-making” R&D support function.

Acknowledgments

We would like to express our gratitude to Jiang Haijun of Sinopec Group Co., Ltd, Huang Xinnan of TBEA Co., Ltd, Liu Yuqiang of Jinchuan Group Co., Ltd, Chen Jianyu of LS Group Co., Ltd, Zheng Yueqiang of Jiuquan Iron and Steel Group Co., Ltd, Cao Zhiguo of China Energy Investment Corporation Co., Ltd, Dong Shaoting of Shaanxi Yanchang Petroleum Group Co., Ltd, He Yu of Shaanxi Nonferrous Metals Holding Group Co., Ltd, and Ying Chao of Wanma Group Co., Ltd. for their contributions to this paper.

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