

Xi'an Promotes the Deep Integration of Innovation Chain Industrial Chain Capital Chain Talent Chain and Domestic and Foreign Experience Learning and Realization Path

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Abstract: Promoting the deep integration of innovation chain, industrial chain, capital chain and talent chain (hereinafter referred to as the "four chains") is of great significance to high-quality economic development. Its essence is to reduce various barriers encountered when innovation factors flow across organizational boundaries, improve allocation efficiency, better play the main role of enterprises in scientific and technological innovation, and enhance the overall efficiency of the national innovation system. The report of the Party's 20th National Congress proposed to "promote the deep integration of the innovation chain industrial chain capital chain talent chain". "Four-chain" integration is not only an important starting point to promote the marketization of factors and build a new development pattern, but also an internal requirement to improve the overall efficiency of the national innovation system, its essence is to effectively allocate various factors under the guidance of the government and the role of the market mechanism. Based on this, on the basis of analyzing the development status and existing problems of "four-chain" integration in Xi'an, this paper draws on the experience of "four-chain" integration, and designs the realization path of "four-chain" deep integration in Xi'an.

1. Introduction

The report of the Party's 20th National Congress proposed to "promote the deep integration of the innovation chain industrial chain capital chain talent chain". "Four-chain" integration is not only an important starting point to promote the marketization of factors and build a new development

pattern, but also an internal requirement to improve the overall efficiency of the national innovation system, its essence is to effectively allocate various factors under the guidance of the government and the role of the market mechanism. At this stage, the deep integration trend of China's "four chains" pulling and supporting each other has yet to be formed. The contradiction between supply and demand in different dimensions between the "four chains" is not only the main factor restricting integration, but also the focus of promoting integration. This paper starts from the analysis of the problems existing in China's "four-chain" integration, and on the basis of sorting out the relevant typical practices at home and abroad, puts forward countermeasures and suggestions [1].

2. Problems Existing in the Development of Xi'an under the Background of "Four-chain" Integration

The integration of "four chains" is closely related to factors such as macroeconomic background, social and cultural environment, policy synergy and consistency, decision-making orientation of innovation subjects, supply-demand relationship of scientific and technological achievements, supply-demand relationship of funds and supply-demand relationship of talents. To promote the integration of the "four chains", we need to focus on resolving the contradiction between supply and demand in each link. In order to further understand the current problems and causes of "four-chain" integration in China, members of the research group conducted questionnaire interviews and field investigations with experts and scholars from research institutes, universities, industry authorities and scientific and technological innovation enterprises. The results show that China's "four-chain" integration still faces the following five problems [2].

2.1. In the Current Sci-tech Innovation Environment, Policy Synergy and Consistency Have Significant Flaws, and the System and Mechanism of Cross-industry and Cross-region Collaboration Need Much Improvement and Optimization

In order to provide strong driving force and support for scientific and technological innovation, various departments and industries have formulated a variety of policies and systems, which are numerous and cover a wide range of areas. However, we have to face it that there are still some problems that cannot be ignored. Among them, the system in some key areas is relatively absent. For example, some emerging science and technology industrial parks, such as aerospace New City, lack clear norms and guidance policies for the application and transformation of cutting-edge space technology, resulting in related enterprises and research institutions facing many uncertainties in the development process. At the same time, the phenomenon of mutual constraints between policies occurs from time to time. For example, in order to encourage innovation of science and technology enterprises, Xi'an High-tech Zone has introduced preferential tax policies, but the loan policies of the financial sector have failed to effectively cooperate with them, making it difficult for enterprises to fully enjoy the policy dividends in actual operation. The integrated layout of a series of systems closely related to scientific and technological innovation, such as fiscal and taxation, finance, state-owned assets management, public institution management, science and technology management, and achievement transformation, is still weak and needs to be further strengthened and improved. In terms of finance and taxation, the implementation standards of tax reduction and exemption policies in different districts and counties in Xi'an are not uniform enough, which affects the innovation enthusiasm of enterprises; In the financial sector, the approval process of special loans for scientific and technological innovation is complicated, and the funds are not timely. In the management of state assets, the regulations on innovation input and risk tolerance of state-owned science and technology enterprises are not clear enough. In the management of public institutions, the innovation incentive mechanism for researchers is not flexible enough; In terms of science and

technology management, the project approval and evaluation system is not scientific enough; Results transformation link, lack of effective industry-university-research cooperation mechanism [3].

2.2. The Supporting Role of Science and Technology Intermediaries in Promoting the Integration of the "Four chains" Needs to be Further Strengthened

First of all, the construction of scientific and technological achievements transformation platform needs to be strengthened. At present, there are a large number of platforms for the transfer and transformation of scientific and technological achievements in Xi'an, but these platforms generally have serious problems of homogenization. Most platforms only have basic information display functions, but seriously lack in-depth docking and negotiation functions at the project level. Secondly, the support of innovation resources for smes is relatively insufficient. Small and medium-sized enterprises in Xi'an face many difficulties on the road of scientific and technological innovation. Due to their lack of funds, venues, equipment, talents, technology and other key elements, many scientific and technological achievements are difficult to transform and land. Third, the pricing mechanism of science and technology intermediaries needs to be improved. The domestic market for the transformation of scientific and technological achievements is still in the early stage of development, and all parties have insufficient understanding of the key role played by scientific and technological intermediaries in the transformation process. Both the supply and demand of the results are generally less willing to pay intermediary fees, which greatly limits the survival and development of science and technology intermediary institutions [4].

2.3. The Implementation Rules for the Transformation of Scientific and Technological Achievements at Different Levels are Relatively Lacking, and the Phenomenon of "Groundless" Transformation Practice Still Exists

As a key link in the integration of "four chains", although the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements and other laws and regulations have made provisions in principle, the specific rules that can effectively guide practice are still lacking. Taking Xi'an City as an example, most scientific research institutes and universities have problems in the organization and implementation of the transformation of results, such as unclear processes and poor links. For example, a scientific research team of a university has developed a new material technology with major application prospects, but in the transformation process, due to the lack of specific organizational implementation rules, do not know how to connect with the enterprise, and do not know what approval procedures need to go through, resulting in repeated delays in the transformation process. In terms of the distribution of transformation responsibilities and rights, there has not yet been a clear and enforceable guiding clause. Like a research institute in Xi'an, researchers have made outstanding contributions in the transformation of results, but because the division of responsibilities and rights is not clear, it is impossible to clarify the share of income they should enjoy, which greatly weakens the enthusiasm of researchers. There are also deficiencies in incentive safeguards. In some universities and research institutes, the incentive for the transformation of results is not enough, and the safeguard measures are not perfect [5].

2.4. The Cohesion of Talents in Some Fields or Key Technical Links is Insufficient, and the Mechanism of Talent Training, Evaluation and Use Needs to be Improved

On the one hand, the total number of scientific and technological talents in China has obvious

advantages, but the structural contradictions are prominent, there is a lack of world-class scientific and technological talents, the construction of strategic scientists, leading talents and excellent engineers is disconnected from the needs of the innovation chain and the industrial chain, and the knowledge orientation of talent training is insufficient to match the demand orientation of industrial development. Taking Xi'an City as an example, in the high-tech fields such as aerospace, there is an urgent demand for compound talents who are proficient in materials science, intelligent manufacturing, avionics and other multidisciplinary knowledge, but the current disciplinary construction cannot effectively meet this demand. For example, an aviation manufacturing enterprise in Xi'an, in the process of developing a new type of aircraft, is in urgent need of comprehensive talents who understand both material mechanics and automation control, but it is difficult to recruit talents who meet the requirements locally, and they have to be hired from other places with high salaries. On the other hand, Xi'an needs to strengthen the discipline setting application orientation, comprehensive talent training needs to be strengthened, and the initiative of enterprises to participate in talent training is relatively limited [6].

2.5. The Problem of Back-end Financing in the Innovation Chain Needs to be Improved Urgently, and the Multiple Barriers to Capital Entry Need to be Removed

The back-end of the innovation chain mainly involves technology research and development, industrialization and commercialization of new products and new processes, etc., which is a key link that requires multiple entities to effectively coordinate to promote the transformation of technological value into economic value. Taking Xi'an City as an example, in the field of biomedicine, some enterprises face a huge funding gap when they enter the industrialization stage after developing innovative drugs. Due to the weak link of commercial value assessment of scientific and technological achievements, it is difficult for financial institutions to accurately judge the potential benefits and risks of projects, leading to hesitation in capital investment. For example, a new anticancer drug developed by a biopharmaceutical company in Xi'an is technically advanced, but due to the lack of authoritative commercial value assessment, financial institutions have doubts about its market prospects, and financing progress is slow [7].

3. The Experience of "Four chains" Deep Integration

3.1. Cooperate with Various Types of Domestic Innovation Entities to Build an Innovation Ecosystem Covering the Full Vertical Innovation Chain and Horizontal Multi-entity Innovation

In 2014, the United States actively established the Manufacturing Innovation Institute, which is clearly positioned to promote large-scale and in-depth cooperation between industry, academia, and U.S. federal laboratories in a number of important aspects such as technology, supply chain, and workforce development through carefully constructed public-private partnership networks. Its goal is to ensure that the United States remains a global leader in advanced manufacturing. The main body of the network covers a number of key departments, including the U.S. Departments of Commerce, Defense, and Energy, and 16 manufacturing research institutes established by the three departments, in addition to the National Aeronautics and Space Administration, the National Science Foundation, the Departments of Health, Agriculture, Education, and Labor. A series of practices of the manufacturing Innovation Institute have significant reference significance: ① law first, strengthen the top-level design. The United States has basically completed the top-level strategic planning and design for the development of intelligent manufacturing by issuing three bills of important guiding significance, namely, the Revitalizing American Manufacturing and

Innovation Act of 2014, the National Manufacturing Innovation Network and the American Innovation and Competition Act of 2021. In addition, the United States has set up a special department to coordinate the various entities involved in the National Manufacturing Innovation Network. For example, in specific practice, the specially established coordination department can effectively integrate the resources of all parties and clarify the responsibilities and tasks of each subject, thus ensuring the orderly advancement of the entire innovation network. ② Public-private partnership (PPP) is adopted. Participants in this model are very extensive, not only the government plays a leading and leading role, but also research institutions to provide cutting-edge technical support and theoretical research, local universities and community colleges to train and transport professionals, venture capital institutions and incubators to provide financial support and business incubation services, manufacturers are responsible for the actual production and marketing.

3.2. Relying on Science and Technology Intermediaries to Carry out Research and Development Needs and Transformation of Results, and Promote the Flow of Technological Factors into the Production Sector

Science and technology intermediaries play a pivotal role in the process of promoting the integration of innovation chain and industrial chain, and are indispensable important subjects. At the practical level, the operation mode of the Belgian Collective Research Centers (CRCs) has a high reference value, which is worthy of our in-depth study and reference. CRCs is a non-profit institution, which not only has a strong R & D function, but also has an excellent scientific and technological intermediary function, mainly for member companies to provide all-round, multi-level services. CRCs will send professional technical consultants to visit enterprises in depth, conduct in-depth exchanges with relevant personnel of enterprises, and comprehensively collect technical requirements information. They will carefully study and analyze the possibility of improving the enterprise process, and according to the actual capabilities and resources of the enterprise, carefully choose the corresponding technology research and development mode, and then promote the research and development activities based on the actual technical needs of the enterprise. For example, when a manufacturing company is facing a problem of inefficiency, CRCs technical consultants will investigate the company's production process and find that there may be room for optimization of a key process. Then, according to the technical capability and financial status of the enterprise, they will suggest that the enterprise adopt the introduction of new technology or independent research and development to improve the process, and finally successfully promote the development of relevant research and development projects.

3.3. Invite Industry Chain Terminal Enterprises to Participate in Scientific Research Projects to Achieve Seamless Docking of Scientific Research and Transformation of Results

The output of basic research and applied research can provide effective support for industrial development, the key premise is that the scientific research team according to the actual needs of industrial development, precise and concise research problems, and inviting enterprises to participate in the R & D program is an effective path. For example, WaterLake, Finland's second largest lake, has suffered from severe pollution problems. In the face of this serious challenge, the local government actively took action and invited the University of Helsinki, Finland, to conduct in-depth research on the water quality monitoring methods of the lake. Because the research of water quality monitoring methods needs to accurately determine the relevant trace elements in water, however, the sensors sold on the market at that time could not meet this high-demand detection task, so it is necessary to work with enterprises to jointly develop. Because of this, the research team invited a well-known local sensor manufacturer to participate in the project and subsequent research

work. In the case of Shuihu, a win-win situation has been achieved among the government, universities and enterprises. For the government, it has successfully solved the problem of water quality monitoring methods, obtained reliable monitoring equipment, and successfully carried out follow-up water quality monitoring work, providing strong support for environmental protection and water resources management. For the university, it not only successfully completed the task of research, but also successfully realized the transformation of research results, and enhanced the scientific research strength and social influence of the university. This is undoubtedly one of the important and feasible ways to promote the deep integration of "innovation chain, industrial chain, capital chain and talent chain". It can give full play to the advantages of all parties, stimulate the vitality of innovation, promote the upgrading and development of industries, and inject strong impetus into the sustainable development of economy and society.

3.4. Build a Basic Research Model Supported by Social Funds Based on the Strategic Cooperation between Industry, University and Research to Help Transform Basic Research Results

Dalian Institute of Chemical Physics, Chinese Academy of Sciences (hereinafter referred to as "Dahua Institute"), as a comprehensive research institution that organically combines basic research, applied research and technology transformation, shows the remarkable characteristics of task-led discipline development. For a long time, Dahua Institute has continuously carried out in-depth and extensive strategic cooperation with local governments, enterprises and other parties, and successfully promoted the transformation of a large number of high-quality research results, which has played a vital role in effectively alleviating the outstanding contradiction between the supply and demand of petrochemical products in China. For example, as early as 2004, Dahua Institute actively cooperated with social funds around the methanol to olefin project. In the process of cooperation, the two sides have jointly faced many technical difficulties and market challenges, and through unremitting efforts and exploration, substantial and important progress has been made in 2010. After further optimization and improvement, in 2014, the project was officially put into operation, not only the new olefins production capacity reached 2.8 million tons/year, but also created up to 6 billion yuan of significant economic benefits.

4. The Realization Path of "Four chains" Deep Integration in Xi'an

4.1. Build a High-quality Industrial Chain and Deploy an Innovation Chain around the Industrial Chain

Aiming at the forefront of global industrial innovation, based on China's scale advantages, supporting advantages and first-mover advantages shown in some fields in the industry, we will gradually and pertinently improve the self-sufficiency rate of upstream R & D and design links, and comprehensively improve the "original creativity" of technology and the "transformation" of results. Actively accelerate the pace of building an emerging industrial chain, vigorously promote the Internet, big data, artificial intelligence and other cutting-edge technologies to achieve deep integration with various industries, and effectively guide innovation resources toward the upstream and downstream enterprises in the industrial chain. With enterprises as the main body, carefully build a number of R & D institutions with key roles such as enterprise key laboratories, engineering centers, and enterprise technology centers around the upstream and downstream industry chains. For example, in the automobile manufacturing industry chain, the upstream automotive research and development design link has improved its independent research and development ability and reduced its dependence on foreign technology by increasing investment and introducing high-end

talents. In the electronic information industry chain, the establishment of enterprise key laboratories has promoted breakthroughs in chip manufacturing technology and provided strong support for industrial development.

4.2. Build a High-level Innovation Chain, and Layout the Industrial Chain Around the Innovation Chain

Always adhere to the comprehensive enhancement of independent innovation ability as a clear goal orientation, the enterprise's scientific and technological innovation and achievement transformation should be accurately targeted at the national strategic needs and the actual needs of the market, highly focused on the key areas and core technologies of the industry, with special attention to strategic emerging industries and future industries, and then form a series of original and leading key technologies. By significantly improving the science and technology supply level of the innovation chain, it will effectively promote the transformation and upgrading of traditional industries, the fission development of emerging industries, and the forward-looking layout of future industries. For example, in the field of biomedicine, breakthroughs in the innovation chain have enabled traditional pharmaceutical companies to transform and produce high value-added biologics, emerging gene editing technology companies have been able to rise rapidly, and for future industries such as cell therapy, technical reserves and industrial planning have been made in advance.

4.3. Build a Highly Enriched Capital Chain and Promote the Deep Integration of the Innovation Chain and the Capital Chain

Scientific and reasonable capital chain layout around all links of the industrial chain and innovation chain, and further increase the investment in scientific and technological innovation, not only to increase the government financial investment in industrial basic research, but also to actively build a diversified investment and financing system platform that can cover all links of the "four chains". We will make the allocation of funds in the innovation chain more flexible, precise and effective. For example, in the new energy industry, the government's financial funds support the basic research of battery technology, while social capital provides sufficient financial guarantee for the production and promotion of new energy vehicles through investment and financing platforms.

4.4. Build a High-level Talent Chain to Provide Talent Support for the Industrial Chain Innovation Chain

Carefully layout the talent chain around the industrial chain, relying on the talent chain to give strong energy to the industrial chain. Actively encourage and guide scientific and technological talents to gather in the front line of the industry, vigorously promote the mutual promotion and deep integration of the talent chain and the industrial chain, and form an excellent situation of "gathering talents by production, generating production by talent, and integrating talent into each other", and ultimately achieve the same frequency resonance of industrial development and talent gathering. Encourage enterprises to focus on the development of urgently needed key core technologies and talents in short supply, implement major research and talent projects, promote more "four-chain" integration tasks proposed by enterprises, and significantly improve the participation and discourse power of enterprises in the establishment, organization and implementation of science and technology projects and talent projects. For example, in the intelligent manufacturing industry, enterprises have trained a group of compound talents who understand both technology and management through cooperation with universities, providing a strong talent guarantee for

industrial upgrading.

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