

Analysis of the integration of the two chains of the equipment manufacturing industry

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Abstract: The article takes equipment manufacturing enterprises as the research object, based on the perspective of two-chain integration, combs relevant literature, explores the connotation and structure of the equipment manufacturing industry chain and innovation chain, further analyzes the two-chain integration network, integration path and integration mechanism of equipment manufacturing, and finally proposes Three suggestions to promote the integration of the two chains: focus on the coordinated development of multiple chains to effectively support the integration of the two chains; adhere to the interaction of multiple entities to build an innovation and entrepreneurship community; improve the construction of systems and mechanisms to shape industrial competitive advantages.

Keywords: Equipment manufacturing; industry chain; innovation chain; integration of the two chains

1. Introduction

The equipment manufacturing industry is a general term for providing equipment for production in various departments. According to industry classification standards, it specifically includes eight categories. It is a core component of the industry and plays a supporting role in the development of the entire industry. With the proposal of "Made in China 2025", the scale expansion and industrial upgrading of the equipment manufacturing industry have been accelerated, providing an action plan for promoting China to basically achieve industrialization by 2025 and enter the ranks of manufacturing powers. The integration of the equipment manufacturing industry chain and the innovation chain plays an important role in promoting China's transformation from a manufacturing country to a manufacturing power, building a modern industrial system, and promoting the upgrading of the equipment manufacturing industry structure. Therefore, this article takes equipment manufacturing enterprises as the research subject, based on the perspective of two-chain integration, explores the integration network, integration path and integration mechanism of the two-chain equipment manufacturing chain, and proposes countermeasures and suggestions to promote the integration of the two chains.

2. Literature review

2.1 Literature review of industrial chain

Academic research on industrial chains mainly focuses on the connotation and stage division of industrial chains. The concept of industrial chain emerged in the Chinese context. The term "industrial chain" was first proposed by Fu Guohua when he was studying the development of tropical agriculture in Hainan. Kong Xiangnian regards the industrial chain as a chain industrial system formed by various industrial departments with technical and economic connections according to certain logical relationships [1]. Sheng Chaoxun regards the industrial chain as a chain form objectively formed between multiple industrial sectors based on certain technical and economic connections, including value chain, enterprise chain, supply and demand chain and space chain [2]. Li divides the wind power industry chain into upstream, midstream and downstream. The upstream is the national wind power manufacturer, which carries out technological innovation and resource integration. The midstream is owned and operated by power generation groups, and the downstream industry consists of the entire power company [3]. The wind power industry chain mainly includes upstream wind power equipment manufacturing, midstream wind power construction, and downstream wind power grid operations. The coupling coordination model between the three subsystems of upstream, midstream, and downstream is constructed respectively [4].

From the perspective of the industrial chain, C J H A used complex network methods and extended gravity models to analyze the evolution of international tungsten competition and its influencing factors. The tungsten industry chain was also divided into upstream, midstream and downstream [5].

2.2 Literature review of innovation chain

Research on the innovation chain focuses on the main body, connotation and stage division of the innovation chain. Li Moyang regards the innovation chain as a chain structure formed by basic theoretical research, applied technology research, development and trial production, etc., and is mainly composed of institutions of higher learning and scientific research institutions [6]. Wang Xueyuan believes that the innovation chain is a complete innovation chain from the incubation of innovative ideas to the output of final products. Multiple innovation entities integrate innovation resources and realize technological creation based on industrial needs [7]. Liu Xiaohui defines the green innovation chain as a complete chain that includes the generation of green innovative ideas, the transformation of green research results, and product creation. Promoting the upgrading and development of the green innovation chain is of great significance for promoting the transformation of corporate structure and the transformation of economic vitality [8]. Using panel data from universities in 30 provinces and regions, Cheng divided the innovation chain into three stages: R&D investment, knowledge output and achievement transformation from the perspective of industry-university-research cooperation, and examined the impact of UIC policies on different stages of the innovation chain [9]. Liang builds an innovation chain cycle system, constructs a cycle system from invention and creation - technological innovation - technology utilization, forming a specific form of the cycle chain from knowledge innovation to technological innovation [10].

2.3 Literature review of two-chain fusion

The integrated development of industrial chain and innovation chain has become a hot research topic today. Most scholars mainly discuss the connotation and significance of the integration of the two chains and the core point of "deploying the innovation chain around the industrial chain, and laying out the industrial chain around the innovation chain". There is a lack of understanding of the two chains. In-depth discussion on the main body, path and mechanism of chain integration. Liang Wenliang pointed out that the integration of the two chains is to achieve value co-creation and industrialization of results through the collaboration of subjects and elements, and to promote the collaborative integration and active interaction of the two chains [11]. Liang Shuguang explored the coupling between the industrial chain, innovation chain and capital chain, and divided the industrial chain into five links: R&D, design, production, sales and service. The innovation chain was divided into basic research, applied research, pilot testing, commercialization and Among the five stages of industrialization, the capital chain is divided into three stages: capital investment, capital operation and capital withdrawal. The coupling between the three chains includes not only vertical coupling, but also horizontal collaboration [12]. In order to explore the impact of the integration of the two chains on the high-quality development of the regional economy, the index system of the innovation chain system and the industrial chain system was established respectively, and a coupling coordination degree model was constructed to measure the coupling coordination degree of the two chains [13].

2.4 Literature review

Looking at the research literature on industrial chains and innovation chains at home and abroad, scholars have achieved certain results and generally divide the industrial chain into upstream, midstream and downstream; the innovation chain is divided into basic research, applied research, pilot testing and commercialization. And five stages of industrialization. However, research on the integration of the two chains focuses on connotation and meaning, and there is still room for research. This article is based on equipment manufacturing enterprises, explores the connotation of equipment manufacturing industry chain and innovation chain, and explores the integration network, path and mechanism of the two chains.

3. Theoretical analysis

3.1 Equipment manufacturing industry chain

The article defines the industrial chain as a collection of production activities between enterprises or organizations that integrate upstream, midstream and downstream resources from R&D to sales. This

article divides the equipment manufacturing industry chain into upstream material collection, midstream products. There are three links including manufacturing and downstream application. The upstream is the basic link of the equipment manufacturing industry chain, which mainly collects and purchases basic materials and parts. The midstream is the core link of the equipment manufacturing industry chain, which is responsible for the production and manufacturing of equipment manufacturing products. , the downstream is the terminal link of the equipment manufacturing industry chain, carrying out product application, operation and maintenance. Taking the core enterprises in the industrial chain as the research object, we purchase raw materials such as steel and carbon fiber as well as electronic components, optical accessories, precision basic parts and other parts from upstream enterprises, and use raw materials and parts to carry out the production and integration of CNC machine tools and equipment machine tools. Manufacturing and assembly of equipment such as circuits, and finally applying equipment manufacturing products to machinery manufacturing, military weapons, aerospace and other fields.

3.2 Equipment manufacturing innovation chain

3.2.1 The connotation of innovation chain

The innovation chain is generally defined from the decomposition of the innovation process and links. This article defines the innovation chain as an open and dynamic chain structure composed of R&D subjects, production subjects and application subjects, which is essentially knowledge and technology. Flow among different innovative entities. This article divides the equipment manufacturing innovation chain into basic research, applied research, pilot testing, commercialization and industrialization. The R&D entities in the equipment manufacturing innovation chain are mostly scientific research institutions, universities and various R&D platforms, which provide a theoretical basis for equipment manufacturing enterprises to carry out knowledge and technological innovation activities and conduct basic scientific research. Knowledge is the core object of the innovation chain and can fundamentally. Solve the technical problem of "stuck neck". Applied research is an extension of new theories and new knowledge in basic research. It is mostly presented in the form of patents, intellectual property rights, and academic papers. It combines basic theory with practical applications and can be directly used in production and life. Pilot tests are "incubators" that promote the industrialization of scientific and technological achievements. They can effectively solve the "two skins" phenomenon of scientific and technological innovation and industrial development, and are an important part of transforming scientific and technological achievements into economic benefits. Commercialization is the process in which production entities use the scientific research results of pilot tests in the technology application stage, and combine the funds, personnel, equipment, information and other resources of equipment manufacturing enterprises to form products, thus bringing economic benefits to the company. Industrialization is the final link in the innovation chain. Scientific and technological achievements are used to empower industrial transformation and upgrading. The economic benefits of industrialization further promote the level of scientific and technological research and development investment and build a circular development system.

3.2.2 Division of equipment manufacturing innovation chain

The horizontal innovation chain refers to core innovation entities such as universities, scientific research institutions, financial institutions, and equipment manufacturing companies starting from a certain product with the goal of meeting market demand, and connecting related entities through knowledge innovation, technological innovation, and product innovation. The exchange and integration of resources between innovation entities ultimately realizes the functional link organization of product marketization and industrialization. Its core links can be divided into five modules: basic research, applied research, pilot testing, commercialization and industrialization.

The vertical innovation chain refers to the development based on the relevance, integration and synergy of knowledge and technology in the upstream and downstream of the industry chain when relying on the upstream raw material and component development, midstream equipment manufacturing and assembly, downstream operations and maintenance of the equipment manufacturing industry chain. The chain structure formed by sex.

3.3 Integration of the two chains of equipment manufacturing

3.3.1 Two-chain fusion network

Li Yongti pointed out that the deep integration of industry, academia and research is to strengthen the

leadership of enterprises, and enterprises are the main body of integration. Highlighting the main position of enterprises in innovation will help enhance the overall innovation strength of enterprises [14]. The integration of "two chains" involves multiple innovation entities. The core layer includes universities, equipment manufacturing collaborative enterprises, equipment manufacturing competitive enterprises, scientific research institutions, intermediaries and users. Universities and scientific research institutions provide them with basic theoretical knowledge and technological innovation resources. In addition, universities also provide enterprises with a steady stream of high-tech talents, and equipment manufacturing enterprises use the resources obtained to improve corporate performance and promote in-depth integration of industry, academia and research. The machine manufacturing and assembly process of equipment manufacturing enterprises is cumbersome, and it is difficult to complete the complex links only by relying on a single enterprise. Equipment manufacturing collaborative enterprises exchange knowledge, information, technology, talents and other resources with equipment manufacturing enterprises, and collaborate to produce unit, warehousing and logistics equipment. Assembling it with the complete equipment is conducive to improving innovation efficiency. User feedback mechanisms are mostly reflected in the downstream links of the equipment manufacturing industry chain. Equipment manufacturing is used in many fields such as aerospace, machinery manufacturing, steel chemical industry, etc. Users provide feedback to equipment manufacturing companies based on their experience in using equipment manufacturing products in order to better improve technology and products, promote technological progress and innovation of equipment manufacturing enterprises, and then promote the improvement of innovation performance. The two-chain integration entities of equipment manufacturing enterprises mainly include universities, scientific research institutions, governments, customers and intermediaries.

3.3.2 Two-chain integration path

The equipment manufacturing industry is the foundation of the real economy. Accelerating the transformation from "Made in China" to "Created in China", especially vigorously developing the equipment manufacturing industry, is a necessary step to promote the construction of a manufacturing power and build new competitive advantages. The integration path of the equipment manufacturing industry chain and innovation chain mainly includes two aspects. First, deploy the innovation chain around the industrial chain. This model is suitable for developing countries, that is, first have an industrial foundation and then innovate the industrial chain. Developing countries need to take advantage of the technological spillover effects of developed countries to imitate and learn high-end technologies, such as core links such as equipment manufacturing and equipment assembly involved in the midstream links of the equipment manufacturing industry chain, in order to upgrade the equipment manufacturing industry chain, and then Promote the innovation performance of equipment manufacturing enterprises. Secondly, the industrial chain is laid out around the innovation chain. This path is suitable for developed countries, that is, technological innovation is first introduced, and then applied to products, and finally industrialized development is achieved. Because developed countries have the core advantage of allocating innovation resources, they can derive independent and controllable industrial chains, invest heavily in basic research, promote the improvement of products transformed from scientific and technological achievements, and then develop high-quality products. For equipment manufacturing companies, that is It has product advantages and innovation advantages, thus promoting the improvement of innovation performance of equipment manufacturing enterprises.

3.3.3 Two-chain fusion mechanism

By sorting out relevant literature, the two-chain integration mechanism is divided into a macro-level innovation resource allocation mechanism, a meso-level innovation project management mechanism, and a micro-level innovation subject collaboration mechanism and innovation resource sharing mechanism [15].

(1) Innovative resource allocation mechanism

The innovation resource allocation mechanism refers to who and how innovative resources, talents, information, and technology are allocated. Innovation resource allocation mainly includes multiple links such as talent resource allocation, fund allocation system, and technology allocation policy. The government should strengthen top-level design, rationally allocate innovation resources, implement the "chain leader system", set leading equipment manufacturing enterprises as chain owners, and government departments as chain leaders, rationally allocate internal and external resources in industrial clusters, and promote "strong chains". Substantial progress has been made in "chain replenishment, chain consolidation, and chain extension", opening up the blocking points and pain points in the industrial chain, and laying the foundation for further promoting the integration of the two chains. Give play to the

key regulatory role of the government's "invisible hand", accurately identify the research and development directions of scientific research institutions, strengthen the dynamic monitoring of key industrial technologies, formulate relevant industrial policies, and rationally plan the layout of innovative resources. For forward-looking research and development fields, increase investment in research and development, formulate special research and development policies, clarify the direction of integrated development of the innovation chain and industrial chain, and form a policy synergy.

(2) Innovative project management mechanism

Innovation projects are an important carrier for the specific implementation of innovation resources. Innovation project management mechanisms refer to the methods and management processes for managing innovation projects, which mainly include the early-stage screening mechanism for innovative projects, the mid-term implementation mechanism, and the later-stage evaluation mechanism for innovative projects. The screening mechanism is mainly to screen out innovative projects in the field of forward-looking research and development. This process requires the participation of enterprise experts so that they can give full play to their opinions, rather than government-led project screening. The enterprise is mainly responsible for project implementation, and the high-quality innovation projects selected in the previous stage will be implemented by the enterprise to further realize the industrialization of innovation results. The innovation project evaluation mechanism is to evaluate the process and results of the implementation of innovation projects, establish a professional review committee, evaluate the technological maturity and technological innovation of innovation results, and focus on the evaluation of the long-term benefits of innovation results.

(3) Collaborative mechanism of innovation entities

In the process of integrating the two chains, multiple entities including enterprises, universities, scientific research institutions, and intermediaries jointly participate and are committed to further promoting the integration of the two chains. First of all, a synergy of goals between universities and enterprises should be formed to avoid the serious phenomenon of "two skins" in science and technology and economy. Some university teachers only evaluate professional titles and shelve the results of innovative projects after the project is completed, cutting off the "transformation of innovative results". The last mile". Secondly, the construction of innovation platforms should be promoted. Innovation platforms are an important carrier for the transformation of innovative projects. The organizational forms are diverse, including industrial technology research institutes, incubators, strategic alliances, national technology research and development centers, etc. Enterprises, universities, and scientific research institutions should be encouraged to wait for multiple subjects to participate. Finally, the government should formulate reasonable policies to reduce risks in the pilot stage of enterprises, encourage enterprises to carry out technological innovation and knowledge innovation, and truly open up the pain points and difficulties of the innovation chain and the industrial chain.

(4) Innovative resource sharing mechanism

Innovation resource sharing refers to the sharing of common knowledge, common technology and basic equipment. Innovation resource sharing is of great significance in promoting resource integration and resource utilization among various entities. First of all, we should strengthen the bridge connecting enterprises and universities, accelerate the further improvement of innovation platforms, and promote school-enterprise alliances so that on-campus infrastructure can be developed free of charge for enterprise R&D personnel and share equipment resources. Secondly, strengthen the dynamic monitoring of common technologies in the industrial chain, effectively identify common technologies and "stuck" technologies in the industrial chain, and solve the problem of insufficient sharing of innovative resources. Finally, core enterprises should play a leading role, form industrial clusters, and bring together small and medium-sized enterprises so that they can also participate in resource sharing and solve problems such as idle enterprise equipment and difficulties in using equipment for small and medium-sized enterprises.

4. Conclusion

The above analysis of the integration of the two chains of equipment manufacturing was carried out from three aspects: the two-chain integration network, the integration path and the integration mechanism. In order to promote better collaborative interaction between the equipment manufacturing industry chain and the innovation chain, suggestions are made from the following three aspects:

(1) Focus on the coordinated development of multiple chains and effectively support the integration of the two chains

The report of the 20th National Congress of the Communist Party of China pointed out that the main position of enterprises in scientific and technological innovation should be strengthened, the development of specialized and new enterprises should be cultivated, the key core technologies of the industry should be focused on, the ability of independent innovation should be enhanced, and the deep integration of the innovation chain, industrial chain, capital chain and talent chain should be promoted. Multi-chain collaborative development helps strengthen the implementation of the innovation-driven development strategy, which still takes the industrial chain and innovation chain as the main body, and the capital chain and talent chain provide effective support for its development. At each stage of industrial development, the purchase of equipment, basic research investment, and product application stages require the capital chain to provide long-term and stable support to prevent the breakage of the capital chain and strengthen the resilience of the industrial chain innovation chain. Fully implement the supporting role of the capital chain in leading industrial enterprises and advanced industrial clusters, and strengthen support for advanced key enterprises. Technology is the primary productive force, and talent is the primary resource. Strengthen the talent cultivation system in colleges and universities, improve the mechanism for introducing high-tech talents, strengthen financial investment in high-tech talents, improve the welfare benefits of high-tech talents, and encourage schools and enterprises to jointly establish talent training centers. R&D personnel occupy a dominant position in the integration of the two chains, and the core technologies they develop provide strong support for the integration of the industrial chain innovation chain.

(2) Adhere to multi-subject interaction and build an innovation and entrepreneurship community

The integrated development of the two chains is a systematic project. It requires the establishment of a multi-subject joint collaboration of "government, industry, academia and research", adhering to the main role of enterprises in innovation, building an innovative integration ecological model, following the development laws of the equipment manufacturing industry, and at the same time leading innovation-driven development. Relying on its own entrepreneurial spirit and adhering to the enterprise's technical needs as the guide, it resolutely wins the battle against the enterprise's key technologies and solves the enterprise's technical problems. Due to the complex production processes of the equipment manufacturing industry, we should vigorously cultivate leading equipment manufacturing enterprises, which will help accelerate the initial formation of the industrial chain, develop industrial clusters, form the scale advantage of the equipment manufacturing industry, and achieve independent control of key technologies in the industrial chain. Innovation is the primary driving force. We should strengthen the research subject status of universities and scientific research institutions, promote the construction of distinctive disciplines, stimulate innovation vitality, strengthen the integration and interoperability between enterprises, universities and scientific research institutions, and promote national key laboratories, college student innovation and entrepreneurship parks, etc. The construction of innovation carriers creates a good atmosphere for academic and cultural exchanges, improves the evaluation mechanism of scientific research results, and focuses on improving the conversion rate of scientific and technological achievements. Strengthen the role of the government as the main body in regulation, improve the design of top-level systems, improve the allocation system of innovative resources such as funds and talents, realize the government's real-time dynamic monitoring of key core technologies in the industry, strengthen supervision and construction in the integration process of the two chains, and formulate precise supporting policies for industrial development. .

(3) Improve the construction of systems and mechanisms to shape industrial competitive advantages

Improve the implementation of the chain length system, combine industrial location advantages and policy advantages, realize the extension of the industrial chain from low added value to high added value, promote the modernization of the industrial chain, and enhance the independent controllability of the industry. Build a "chain length + chain owner" community model.

References

- [1] Kong Xiangnian. *The operating mechanism and construction path of industrial technology research institutes based on the integration of innovation chain and industrial chain* [J]. *China University Science and Technology*, 2019(10):86-89.DOI:10.16209/j.cnki.cust.2019.10.021.
- [2] Sheng Zhaoxun. *Ideas and strategies for promoting the modernization of my country's industrial chain* [J]. *Reform*, 2019(10):45-56.
- [3] Li C B , Chen H Y , Zhu J ,et al. *Comprehensive assessment of flexibility of the wind power industry chain*[J].*Renewable Energy*, 2015, 74(feb.):18-26.DOI:10.1016/j.renene.2014.07.045.

- [4] Dong F , Li W .Research on the coupling coordination degree of "upstream-midstream-downstream" of China's wind power industry chain[J].*Journal of Cleaner Production*, 2020, 283.DOI: 10.1016/j.jclepro. 2020.124633.
- [5] Huang J, Ding Q, Wang Y, et al. The evolution and influencing factors of international tungsten competition from the industrial chain perspective[J]. *Resources Policy*, 2021, 73: 102185. DOI:10.1016/j.resourpol.2021.102185.
- [6] Li Moyong. Deep integration of innovation chain and industrial chain: industrial innovation service system perspective[J].*Exploration*,2023(05):175-183.DOI:10.16059/j.cnki.cn43-1008/c.2023.05.019.
- [7] Wang Xueyuan. Design of "interchain integration" path of industrial chain and innovation chain from the perspective of multi-agent collaboration [J]. *China Science and Technology Forum*,2023(09):48-58.DOI:10.13580/j.cnki.fstc.2023.09.001.
- [8] Liu Xiaohui. Research on the impact of innovation factor configuration on the upgrading of green innovation chain [J/OL]. *Scientific and technological progress and countermeasures:1-10*[2023-10-23].<http://kns.cnki.net/kcms/detail/42.1224.G3.20230808.1608.006.html>.
- [9] Cheng H , Zhang Z , Huang Q ,et al.The effect of university–industry collaboration policy on universities' knowledge innovation and achievements transformation: based on innovation chain[J].*Springer US*, 2020(2).DOI:10.1007/s10961-018-9653-9.
- [10] Liang L X, He Y. The Study on the Cycle of Technological Innovation Chain[C].*The 4th International Conference on Wireless Communications, Networking and Mobile Computing*.
- [11] Liang Wenliang. The connotation, structure and dynamic factors of the "two chains" integration of the industrial chain innovation chain [J]. *Technology and Industry*,2023,23(03):62-68.
- [12] Liang Shuguang. Research on the mechanism and path of coupling of innovation chain, industrial chain and capital chain[J].*Accounting Monthly*,2023,44(13):118-124.DOI:10.19641/j.cnki.42-1290/f.2023.13.016.
- [13] Liu Deguang. Research on the impact of industrial chain innovation chain integration on high-quality regional economic development [J]. *Modern Management Science*,2023(02):38-47.
- [14] Li Yongming. Strengthen the in-depth integration of industry, academia and research led by enterprises, and lead the improvement of Jiangsu's industrial independent innovation level [J]. *Modern Management Science*,2023(01):3-7.
- [15] Liu Jingyue. Research on the development paths and mechanisms of innovation chain and industrial chain integration from the perspective of industrial policy: Taking Shenzhen as an example [J]. *Research on Science and Technology Management*,2022,42(15):106-114.