Research on the Collaborative Innovation of Military-Civilian Integration Based on the Perspective of Industrial Agglomeration

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Abstract. Based on the classification and analysis of the main subjects and function orientation of collaborative innovation of military-civilian integration industry, this paper demonstrates how to enhance the collaborative innovation capability in the military-civilian integration industry from the perspective of industrial agglomeration, constructs the theoretical framework of collaborative innovation system, and finally proposes suggestions on improving the collaborative innovation capability of the industry.

1. Introduction
The General Secretary Xi, once clearly proposed in an important speech that the development of military-civilian integration is to be raised into the national strategy. The "Made in China 2025" strategy also clearly stated that we should vigorously develop the military-civilian integration industry and actively promote the transformation and apply of high-tech, products and services for both military and civilian usage. If industry is the lifeline of the national economy, then the military-civilian integration industry can be said to be the backbone of the nation. It is characterized by the integration of capital, knowledge, and intensive labour. The integrative development of military and civilian is an important way to achieve optimal resource allocation and to enhance the technological innovative ability of industries. It plays an important role in adjusting the industrial structure as well as in national economic development under the new normal.

The innovation of military-civilian integration industry is a linkage process involving multiple subjects’ participation, multiple resource interactions, and interdisciplinary technology integration, comprehensive crossover and mutual support. It requires cooperation and coordination among various entities, so technological innovation cannot be achieved without coordination. Accelerating the establishment of a sound military-civilian integration and innovation system and forming a new pattern of all factors, multiple fields and high efficiency for deep integration of military and civilian technology are the basic projects, key links and pilot fields of the national military-civilian integration strategy and innovation-driven development strategy, which are tightly related to national security and development (Dong, X.). To this end, this paper constructs the theoretical framework of the military-civilian integration industry’s collaborative innovation system, and further explores how to achieve the
integration of innovation factors thus to realize the collaborative innovation capability of the military-civilian integration industry.

2. Literature review

2.1. Research on Industrial Agglomeration and Collaborative Innovation System

Foreign research on the combination of industrial agglomeration and collaborative innovation mainly focuses on the three major aspects of the motivation, elements and modes of collaborative innovation. Cooke (1992) pointed out that regional innovation systems contribute to the improvement of regional technological innovation. Such systems are mainly composed of enterprises, universities and scientific research institutions. Wiig (1995) argues that regional innovation systems should consist of five interconnected subsystems, including enterprise systems, research institution systems, training systems, and other intermediaries such as the governments and banks. Meeus (1999) believes that enterprises are the core elements of the regional innovation system, and other subjects, including universities and research institutions, are all around the enterprise to carry out innovative activities. Doloreux (2002) believes that the focus of the innovation system is to highlight knowledge production, which, under the organic connection among enterprises, research institutions and universities, and under certain institutional and regulatory arrangements, is conducive to the dissemination and diffusion of knowledge and technology. (Feng S.)

The research of domestic scholars mainly focuses on aspects like innovation indicator system, innovation network, coordination mechanism and innovation mode. Wang J. (2001) believes that the regional innovation system is a process of interaction and innovation among various economic entities including enterprises, universities, research institutions and individuals in the process of mutual communication and cooperation. Taking the software and information service outsourcing industry as an example, Ma F. and co-workers demonstrated the five conditions for the industrial agglomeration model and collaborative innovation development of the industry from the enterprise level and the industry level. On the basis of an overview of the previous literature, Zhang C. sorted out the proposition of the industrial agglomeration’s innovation effects, and identified three micro-mechanisms in industrial agglomeration’s promotion of innovation, which are the knowledge spillover mechanism, the knowledge-specific attribute mechanism and the agglomeration enterprise interaction mechanism, thus to create a model of Innovation system.

2.2. Research on Collaborative Innovation of Military and Civilian Integration Industry

At present, scholars have carried out various researches on the collaborative innovation of military-civilian integration industry from subjects like the operational mechanism, influencing factors, index system, development mode, synergy degree, group decision-making. Among them, the research on the collaborative innovation of military-civilian integration industry includes: Zhang W. et al., applying the method of stepwise regression analysis, have studied the impact of knowledge spillover, technological innovation on the output value of military-civilian integration industry and the interactions between knowledge spillover and technological innovation. Zhang C. and others explored the driving factors and measurement index system of strategic emerging industries’ technology integration from the relationship between industrial integration and technology integration. Zhang J. et al. analyzed the problems existing in the process of collaborative innovation of the transformation between Xi’an’s military and civilian entities. And from the perspective of collaborative innovation of “government, production, university, research and application”, they proposed countermeasures respectively for the collaborative innovation of transformation between Xi’an’s military and civilian entities.

Based on the previous literature, it can be seen that the research on collaborative innovation system are mainly conducted from the enterprise level and the industry level. The premise of this paper is to construct a collaborative innovation system from the military-civilian integration industry level. Besides, the combination of industrial agglomeration and collaborative innovation is of great
significance in improving the industrial innovation capability, while at present, the literature is barely found to has studied the military-civilian integration innovation system from the perspective of industrial agglomeration. To this end, this paper constructs the theoretical framework of the military-civilian integration industry collaborative innovation system, and further explores how to achieve the integration of innovation factors and realize the synergy innovation capability of the military-civilian integration industry.

3. Analysis of the main body of collaborative innovation

Malerba believes that the industrial innovation system has seven basic elements: products and services, participants (including companies, universities, governments, financial institutions, etc.), knowledge and learning processes, basic inputs and needs, corporate interaction mechanisms, competition and selection processes. In the research of innovation-driven collaborative construction in the development of military-civilian integration, Du D. and others, based on Michael Porter diamond Model, divide innovation elements into basic elements and variable elements. Among them, enterprises, military, universities, research institutions and intermediaries are the internal elements in military-civilian integration innovation systems, and market and government are external variable elements, which respectively play the role of oriented and regulatory elements.

Based on the previous literature and research, the main body of collaborative innovation of military-civilian integration industry includes research institutes, universities, enterprises, governments, markets and intermediary organizations. We divide the above six subjects into the core subjects and supporting subjects of collaborative innovation. The core subjects are research institutes, universities and enterprises, which are the backbone of collaborative innovation; the supporting subjects are government, market and intermediary organizations, which serve in building the platforms for the collaborative innovation of research institutes, universities and enterprises, and form an essential part.

Table 1. Description of the Main Subjects of Military-Civilian Integration and Collaborative Innovation

| Category         | Name                        | Main Functions                                      |
|------------------|-----------------------------|------------------------------------------------------|
| Core Subjects    | Research Institutes         | Applied research, technology development, product development |
|                  | Universities                | Basic research, applied research                     |
|                  | Military-Civilian Enterprises | Product development and manufacture                  |
| Supporting Subjects | Government                 | Building platform, guiding and supporting           |
|                  | Market                      | Resource allocation, demand orientation              |
|                  | intermediary organizations  | Information technology, financial services         |

Remarks: Content of the above table are organized and classified according to relevant literature by the authors.

Research institutions and universities are the very source of military-civilian integration technology innovation. They master the key common knowledge and technology needed in the process of military-civilian integration and collaborative innovation, and provide basic theoretical support for the needs of military-civilian integration to transfer from theoretical needs to reality. Enterprises (military enterprises and private enterprises) are the main implementers of military-civilian integration and collaborative innovation, and they will carry out different innovative behaviors according to their own attributes and decisions. Military enterprises mainly provide military innovation and developed products out of technology research for the military. While learning from the technological advantages and flexible mechanisms of civilian enterprises to independently produce military products, they will
entrust some weapons and equipment production to qualified civilian enterprises, and to make up to problems like insufficient funds and lagging mechanisms through the production technology of civilian enterprises. Civilian enterprises are mainly oriented to market demand, emphasizing the adjustment of innovation activities of different subjects through market mechanisms and standardizing market incentives and stimulating the enthusiasm of innovation among the subjects, and while doing production for military, they also provide the civilian side with more qualified and better serviced market-oriented products. These promote the deep integration of military and civilian technological innovation. The core of military-civilian integration is the mutual cooperation between military and private enterprises. Through the mutual support of military and civilian enterprises, the technical advantages, management tools and methods of all entities are brought into play, and the dual regulation mechanism of the market and the government is formed to promote the common development of all entities.

The government is the promoter of technological innovation activities, and is both a participant and a manager in the innovation activities. It can promote collaborative innovation by improving infrastructure, creating an innovative environment, and establishing indirect means such as communication platforms and information exchange channels. The government can also directly participate in innovation through the planning and investment of major projects, and use administrative means to compensate for market defects. The market is the most important environment and conditions for technological innovation activities. Reasonable market structure, moderate market competition, good market order, and fair market access mechanism are guarantees for the orderly evolution of technological innovation activities. Intermediaries function as bridges and way of communication in the innovation system and are an important force in the process of collaborative innovation. The technology innovation intermediary is comprised of industry associations, training institutions, firms and venture capital institutions that provide services to support innovation and allocate resources and provide other social services. Altogether, the intermediaries support innovative activities such as technology development, consulting and transfer.

4. Construction of the collaborative innovation model

Through sorting out the relevant literature, it is found that the collaborative innovation capability of the military-civilian integration industry is affected by the following aspects: first, the collaborative innovation subjects and their relationships; second, the collaborative innovation management system and its operational mechanism; third, the policy environment and resource allocation efficiency; and fourth, the market orientation and situation of results operation; the fifth is the research and development talent and its incentive mechanism. Meanwhile, the collaborative innovation of the military-civilian integration industry presents the following characteristics:

First, whether it is institutional evolution or technology integration, there is a path dependence phenomenon (Chun X.) . Therefore, the military-civilian integration industry needs to resort to the government for assurance like guidance, overall planning, policy support, etc.; it also needs full play of the role of the market mechanism and to use the competition mechanism to stimulate diversified forces. Secondly, Zhang W. has come out in her research that there is positive correlation between knowledge spillover and technological innovation, and the research shows that knowledge spillovers within the industry and knowledge spillovers between industries have all promoted the development of the military-civilian integration industry. Furthermore, it argues that the specialization of regional industry is more conducive to the development of military-civilian integration industry than the diversification of industry. The third is the research on the theoretical basis and connotation of the collaborative innovation. Collaborative innovation is an innovative organization model with knowledge appreciation as the core and with production, study, research and application combined together. (Chen J.) At the same time, the integral development of military-civilian technology is essentially a process of technology diffusion. Technology gap is the fundamental driving force for the integration of military and civilian technology while producing a variety of effects to enhance economic growth (Wang Y.) . For example: the integration effect of technology diffusion, the
multiplication effect of advantage stacking, the interaction effect of sharing collaboration (Du R. et al.). Du D. and others, based on innovation elements, structural systems, innovation environment, etc., have built innovation-driven collaborations in the development of military-civilian integration.

It can be seen that the military-civilian integration, through its own improvement of quality and effect, promotes the rise of the economic structure to the high-end in the value chain and enhances the overall strength of the country. The most important thing to achieve collaborative innovation in the military-civilian integration industry is to establish a sustainable and collaborative innovation mechanism and cooperation model with tangible products, projects or intangible technologies and knowledge. It can build consensus, coordinate various interests, achieve effective resource integration, share results, and maximize the benefits of innovation outputs.

Based on the research of the above two parts of this paper, a collaborative innovation model for military-civilian integration industry is conducted as follows:

![Figure 1. Theoretical model of collaborative innovation system for military-civilian integration industry](image)

Figure 1 basically constructs the innovation direction and value appreciation process in the process of industrial collaborative innovation. In fact, previous research shows that all industrial innovation driving factors include talents, technology, capital and institutions. These innovative factors are provided and undertaken by different subjects. For example, the core subject brings together talents and technologies; the supporting subject gathers capital and institutions. And the agglomeration and integration of these innovative resources that are conducive to the appreciation of the industrial chain will not only facilitate the transformation of innovation results, but also significantly drive the related enterprises to participate in the innovation chain and realize the connection between the industrial chain and the innovation chain.

5. Collaborative innovation of military-civilian integration industry from the perspective of industrial agglomeration
The collaborative innovation of military-civilian integration industry is inseparable from the accumulation of innovation factors, and industrial agglomeration can realize the endogenous accumulation of innovation factors inside and outside the industry, and then exert the cumulative effect of factors. The essence of the agglomeration effect is reflected in the cyclical accumulation process of innovation activities and the external economy (Xv K. and Wang J, 2006). The core of this cyclical accumulation process is to exert “learn in interaction” or “knowledge spillover and diffusion”.

The source of knowledge required for technological innovation can be generated from both within the innovation subject and externally. The effect of innovation depends on whether the required resources can be effectively integrated. The military-civilian technology innovation system increases its knowledge and improves its ability to create new knowledge by continuously absorbing the knowledge of partners.

5.1. Talent and technology accumulation provide material basis for collaborative innovation of military-civilian integration industry

The talent as a factor refers to the personnel who directly engage in and provide direct services for collaborative innovation activities. It is the foundation to promote the development of collaborative innovation. Only when the talent level is continuously elevated can we gain competitive advantage for collaborative innovation. Generally, the more technology-intensive an industry is, the higher level of technology it contains, and the manufacturing techniques and production processes of products are relatively complex, so the level and quality of talents required for integration are higher.

The technology elements, especially the key technologies with independent intellectual property rights, are the core elements for the development of collaborative innovation and an important part of the core competitiveness of the military-civilian integration industry. Michael Porter divides a country's economic development into four stages: factor-driven, investment-driven, innovation-driven and wealth-driven. The past way of relying on traditional factors and investment to drive the economy has gradually shifted to innovation-driven, thus technology innovation is the key means to take the upstream of the value chain.

5.2. System and capital accumulation provide favorable conditions for collaborative innovation of military-civilian integration industry

Systematic factors support the aggregation of innovative elements. The government encourages and accelerates the agglomeration of systematic factors by formulating relevant policies. A good policy system can give full play to the guiding role of the government, encourage development around the industry and market demand, and use market mechanisms to gather innovative resources to enhance the innovation capability of enterprises and form industrial competitiveness. The systematic factors, used with reasonable disciplinary allocation, brings together the advantageous resources of industries, universities, research institutes and intermediaries, and combining with enterprises to guide the development of innovative resources to the industrial development, emphasizing the integration of production, universities and research, technology integration and value chain upgrading.

Capital factors can be divided into monetary capital and material capital, which refer to the funds needed for scientific and technological activities, and is one basic condition to realizing the collaborative innovation. Capital investment can be used to carry out construction for enterprise’s research and development institution, industry-university-research cooperation and fast transformation of technological achievements. However, the accumulation of capital elements has brought technological innovation to the military-civilian integration industry. The agglomeration of capital elements can be analyzed from both scale and efficiency: in terms of scale, it is necessary to look at the ratio of input and output factors to total factors; in terms of efficiency, it is the ratio of output factors to input factors.

6. Conclusions and suggestions

6.1. Strengthen government guidance and promote industrial integration and collaborative innovation

Emphasize the government's guidance and service functions. The essence of industrial integration is the integration of technology, knowledge and talents, the accumulation and application of knowledge, the research and development of innovative technologies, the cultivation and introduction of compound research and development talents, and the continuous injection of new elements for the collaborative innovation of the military-civilian integration industry. To achieve these, the government
needs to take advantage of the situation to establish and cultivate an environment for collaborative innovation of military-civilian integration, and to establish a collaborative innovation platform based on the subjects of collaborative innovation, which will help in reducing costs, accelerating the transformation and transfer of knowledge and technology, tightening communication and linkages between innovation subjects, enhancing trust, and reducing coordination costs between subjects.

6.2. Improve the Innovation Support System and Exert the Collaborative Innovation Effect

It can be seen from the above that collaborative innovation focuses on collaboration. Collaboration is not only reflected in the core subjects of innovation, but also in the supporting subjects. It is necessary to cultivate and develop deep and internal collaboration of the two through the improvement of services in technology, information and finance. Optimize the collaborative innovation environment, promote communication among various subjects, coordinate and standardize market conducts, and enhance the liveness and innovation ability among various subjects through Intermediary organizations.

6.3. Build a Collaborative Innovation Network of Core and Supporting Subjects to Effectively Exert Coupling Effects

Establishing connections among the subjects of the collaborative innovation of military-civilian integration can constitute a collaborative innovation network. The purpose is to realize the resource sharing, knowledge transfer and technology diffusion of each innovation subject, and finally form the appreciation and innovation of knowledge, technology and value, so as to improve overall innovation capabilities.

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