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Mechanism Innovation from Industry-University-Research Collaboration Innovation to Deep Integration

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Abstract: *Industry-university-research collaborative innovation not only contributes to the flow of knowledge within the national innovation system, but is also a basic way to enhance the country's industrial technological capabilities. Aiming at the problem analysis of the collaborative innovation of industry-university-research institutes, drawing on the experience of deep integration of industry-university-research institutes abroad, the mechanism innovation from collaborative innovation of industry-university-research institutes to deep integration is proposed: The government should play an effective guiding role, give play to the role of the market in resource allocation, build a reasonable rights and interests distribution mechanism, build a value dimension of common development, and establish a joint talent training mechanism. Through the research of this topic, an innovation and entrepreneurship mechanism that is conducive to the transformation of scientific research results is constructed, and the relationship between universities and the government, industry and various innovation and entrepreneurship institutions is rationalized. Establish a benign interactive service management system, cultivate innovative and innovative talents, promote the aggregation of innovative elements, stimulate innovation potential, and promote the deep integration of technology and economy.*

Keywords: *Industry-University-Research; Collaborative Innovation; Deep Integration; Experience for Reference; Mechanism Innovation*

1. Introduction

"Collaborative innovation" refers to the effective aggregation of innovation resources and elements, and the in-depth cooperation achieved by breaking through the barriers between innovation entities and fully releasing the vitality of innovation elements such as "talents, capital, information, and technology" built by each other. Industry-university-research collaborative innovation is a combination of enterprises, universities, and scientific research institutions that form a community of interests for a period of time based on the sharing of innovation resources and complementary advantages, and the principles of cooperative research and development, benefit sharing, and risk sharing. Jointly carry out scientific and technological innovation and promote the transformation of achievements. Industry-university-research collaborative innovation not only contributes to the flow of knowledge within the national innovation system, but is also a basic way to enhance the country's industrial technological capabilities. Since the 1980s, industry-university-research collaborative innovation has emerged in large numbers around the world, and has evolved from developed countries to developing countries. At present, industry-university-research cooperation has become an important model for promoting technological innovation and technological progress in the world. The substantive effect of innovation is the survival of the fittest and the elimination of the old. It is necessary to focus on building a technological innovation system with enterprises as the main body, market-oriented, and the combination of production, education, and research, and pay attention to giving full play to the talents of entrepreneurs. Accelerate scientific and technological innovation, strengthen product innovation, brand innovation, industrial organization innovation, business model innovation, increase effective supply, and create effective demand.

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2. Research Significance

This topic enriches the basic theory of industry-university-research collaboration innovation, conforms to the policy orientation of the country and Liaoning, solves the key problems of Liaoning's substantive industry-university-research alliance development, and has important theoretical and practical value to the economic and social development of Liaoning.

2.1 Promote Liaoning to Form Innovative Synergy

Through the research of this subject, we will continue to strengthen the market-oriented role, optimize the environment of industry-university-research institutes, and promote the transformation of industry-university-research cooperation in Liaoning from "government-led" to "market-driven". A new operating mechanism that closely integrates production, education and research with the intermediary service system is truly formed, with enterprises as the main body, universities and institutes as the support, government policies as the guidance, and intermediary service system. To truly realize the in-depth integration of industry-university-research entities such as enterprises, universities and scientific research institutes, and form a joint innovation force in Liaoning.

2.2 Helping Liaoning's High-Quality Development

Through the research of this topic, we will effectively promote the design of the governance system for the deep integration of industry, academia and research, effectively improve the ability and level of scientific and technological governance, better follow the laws of the market, optimize the allocation of innovation resources, promote the aggregation of innovation elements, and stimulate innovation potential. Bringing together innovation resources from all walks of life, accelerating the construction of a modern economic system, promoting the in-depth integration of industry, academia and research to help Liaoning's high-quality development, all-round revitalization leads the revitalization of the old industrial bases in Northeast China in the new era.

2.3 Cultivate Innovative and Entrepreneurial Talents

As a major province of higher education, Liaoning is at the forefront in the process of popularization of higher education, and has unique advantages in educational scale and resources, regional policies and individual discipline construction. Through the research of this topic, an innovation and entrepreneurship mechanism that is conducive to the transformation of scientific research results is constructed, and the relationship between universities and the government, industry and various innovation and entrepreneurship institutions is rationalized. Establish a benign interactive service management system, cultivate innovative and innovative talents, and consolidate the dominant position of higher education in Liaoning.

3. The Experience of Foreign Industry-University-Research Deep Integration for Reference

The deep integration of foreign industry-university-research institutes has gained a lot of rich experience, which is of reference significance.

3.1 U.S.

The university-based industry-university-research collaborative innovation alliance is a typical model of collaborative innovation in the United States. With the support of the National Science Foundation's seed fund, the alliance's innovation capability has been enhanced. Gradually transition from being funded by foundations to being funded by universities, corporations or other sponsors. From the perspective of organizational form, the alliance can be formed by a combination of a university and several enterprises, or by a combination of multiple universities and a number of enterprises. The alliance was founded on the basis of universities. Generally, university administrators serve as directors, and enterprise administrators serve as cooperation directors. They are responsible for daily work, project decision-making and resource allocation and other related affairs, and play the role of coordinator between universities and industries. The advantages of this model are [1]: gather superior resources, participate in multiple parties, give full play to the advantages of talents, and carry out multidisciplinary and cross-disciplinary research cooperation. It will help the alliance to carry out

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research based on industrial needs, and promote industrial innovation and productivity improvement.

3.2 U.K.

Universities play an important role in knowledge creation, transfer, application and diffusion, which accelerates the formation of a modern innovation system. From the perspective of development, the establishment of the modern collaborative innovation system in the UK has experienced the dual structure of "university-enterprise" from the early stage. It has gradually evolved into a "university-enterprise-government" triple-helix structure, and then evolved into a four-helix industry-university-research structure with "university-enterprise-government-public" participation and mutual benefit. The British government has established a long-term strategic partnership with the industry to jointly cultivate development opportunities [2].The government provides a variety of preferential policies and conveniences for universities and enterprises, guides and gathers universities, scientific research institutions and enterprises to actively participate in innovation activities, quickly forms collaborative teams, and solves problems in all aspects of the innovation chain. At the same time, it has expanded the way of training innovative talents. Universities undertake R&D tasks and play a leading role and a core fulcrum in the innovation system.

3.3 Japan

After more than half a century of exploration, the Japanese industry-university-research cooperation model has achieved remarkable results and has become a successful paradigm recognized by the world. The government conducts an annual survey on the development of industry-university-research institutes, compares it with the previous development model, path and strategy, predicts the later trend, and revises the policy to avoid obstacles and harm caused by lazy government behaviour. The basic feature of the industry-university-research cooperation model is "government-led, administrative coordination", which is continuously optimized under the encouragement of the government, supplemented by various norms, policies, systems and laws, and steadily promotes the implementation of industry-university-research institutes. Most of the Japanese industry-university-research institutes are led by industry associations, enterprises, universities and professional institutions. In terms of fund raising and profit compensation, enterprises are inclined to universities as much as possible, giving full play to the advantages of reciprocal cooperation and maintaining long-term cooperation.

3.4 Germany

Germany's leading position in the process of world economic growth is closely linked to the persistent pursuit of technological inventions, high-level education and high-quality products, and industry-university-research cooperation has played an important role. The German industry-university-research cooperation model emphasizes consistent goals, long-lasting processes and maximization of efficiency. The basic structure and operation methods are as follows: The plan is initially proposed by the enterprise, and the content involves the cooperation method, the investment and guarantee of funds, the responsibilities and rights of all parties, and negotiated with the universities to finally form a plan acceptable to all parties. Aiming at the market and carrying out market-oriented, industrialized and commercialized research and development project cooperation, colleges and universities have obtained resources and released the productivity value of knowledge, and enterprises have gained market and profits. The unique "consultant cooperation system", the enterprise grants the right to consult to the university professor, especially respects the professor's suggestion, and transmits and opens the information of the enterprise to the consultant at any time.

3.5 South Korea

South Korea's scientific and technological innovation is a joint research system of government, industry, academia and research, and the government, enterprises, universities and scientific research institutions cooperate with each other. Major scientific research projects are determined by the government and developed by government-run scientific research institutions, which have accounted for more than half of the total number of research institutions in the country [4]. In order to promote technological innovation, the government has formulated a series of preferential tax and financial policies to expand capital investment in technological development. In order to improve the utilization of scientific and technological resources and the efficiency of research and development, reform the government's scientific research system, separate research institutes from government departments, and

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establish basic scientific research associations, industrial technology research associations and public welfare technology research associations according to different fields. Project funding is tilted towards research institutes, the funding for non-key research institutes is reduced, privatization is gradually implemented, and the pace of technological innovation is accelerated. In order to better implement technology development and technology transfer, a training plan for technology transfer engineers has been implemented.

4. Mechanism Innovation from Industry-University-Research Collaboration Innovation to Deep Integration

Establish a technological innovation system with enterprises as the main body, market-oriented, and deep integration of production, education and research, support large and medium-sized enterprises and various entities to integrate innovation, and innovate the mechanism for promoting the transformation of scientific and technological achievements. Actively develop new driving forces, strengthen standard guidance, and improve the basic capabilities of the industry and the modernization level of the industrial chain. In the grand process of building a powerful modern socialist country, collaborative innovation and deep integration of industry, academia and research are playing a key role. In view of the current problem analysis of the collaborative innovation of industry-university-research institutes, this research proposes an innovation mechanism from multiple perspectives. This realizes the coordinated operation among the participating entities and elements, ensures the benign interaction of collaborative innovation organizations, promotes cross-field and cross-industry collaborative innovation, and promotes the deep integration of technology and economy.

4.1 The Government Plays an Effective Guiding Role

Whether from the vertical perspective of the development history of industry-university-research institutes, or from the horizontal perspective of the current situation of industry-university-research cooperation at home and abroad, the government plays a key role in industry-university-research institute cooperation. According to the transaction cost theory, if the market transaction behavior has high cost and risk, the enterprise will abandon the market transaction and turn to the market internalization, so as to reduce the transaction cost, and the market internalization process will generate additional management costs. Industry-university-research cooperation is actually a market transaction behavior, and transaction fees will be incurred in the process of selecting partners, conducting cooperation, and sharing the results of cooperation. The Coase theorem in economics holds that when transaction costs are not zero, different rights definition and distribution will bring about resource allocation with different benefits. A good institutional arrangement is the basis for optimizing resource allocation [5]. Industry-university-research cooperation itself is an institutional arrangement that attempts to reduce transaction costs. The smooth achievement and effective operation of this institutional arrangement requires reasonable regulation by a third party. Therefore, the government plays a very important role in industry-university-research cooperation, and the government's role is a key factor affecting the success or failure of industry-university-research cooperation. If the government wants to become a participant in the deep integration of production, education and research, it needs to actively guide the cooperative innovation mechanism and promote the transformation and upgrading of the industrial structure [6]. The government must become a service provider to promote the deep integration of production, education and research, strengthen the transformation of scientific research achievements, and provide necessary financial support.

4.2 Give Full Play to the Role of the Market in Resource Allocation

The market determines the allocation of resources, which is a general law of the market economy and a concentrated expression of the essence of the market economy. The practice of the historical development of human society has proved that the market is the most efficient way of resource allocation at present. In real economic life, it is necessary to greatly reduce the direct allocation of resources by the government, to promote the allocation of resources based on market rules, market prices, and market competition to maximize benefits and efficiency, and to promote effective incentives for property rights and free flow of factors [7]. Enterprises understand the needs of society best and respond most sensitively to the market. To establish the main role of enterprises, we must make good use of the role of the market in allocating resources. There are many measures that the government can take, among which the most important and most effective is to use the means of the market economy to

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carry out macro-control by combining legislation and economic lever adjustment. To promote the in-depth integration of production, education and research, it is necessary to better follow market laws, optimize the allocation of innovation resources, promote the aggregation of innovation elements, and enhance the innovation capability and market competitiveness of enterprises. Enterprises should also take the initiative to stay close to the market, accurately grasp the development trend of science and technology, provide products and services with market prospects, and improve the success rate and efficiency of innovation. Improve the market-oriented mechanism for technological innovation, and give play to the market's guiding role in the direction of technological research and development, route selection, factor prices, and the allocation of various innovation factors.

4.3 Build a Reasonable Equity Distribution Mechanism

A good profit distribution mechanism for industry-university-research cooperation can optimize the distribution of interests of all parties involved, which is conducive to the long-term and stable development of industry-university-research cooperation. The core of the industry-university-research benefit distribution mechanism is the distribution method and debugging relationship of benefits. Collaborative innovation involves the interests of all participants, and the result of rights and interests distribution directly restricts the healthy development of collaborative innovation [8]. First, establish and improve the risk responsibility mechanism for collaborative innovation. Through negotiation, all participants sign a venture capital agreement and set up an innovation venture fund. On the one hand, through scientific analysis and evaluation of risks in advance, the probability of success of collaborative innovation can be effectively improved; on the other hand, possible failures or losses can also be shared. Second, establish and improve the benefit distribution mechanism of collaborative innovation. The benefit distribution mechanism must be able to reflect the core capabilities and performance of collaborative innovation participants, input resources, and the value of their respective outcomes. Based on the actual contributions of various main elements, adhering to the principle that whoever contributes more will benefit more, rationally distribute the benefits created by collaborative innovation. Third, government departments and science and technology intermediaries should also improve relevant laws and regulations, clarify the legal protection of the responsibilities, rights and obligations of various entities in collaborative innovation, and communicate and coordinate regularly to resolve conflicts in a timely and effective manner. Ensure that everyone works continuously for a common goal and reasonably share the benefits.

4.4 Build the Value Dimension of Common Development

The deep integration of production, education and research into the innovation system not only seeks economic, cultural and educational interests, but also ensures an effective synergistic relationship on the premise of freedom and equality of all subjects. In the end, it will achieve deep integration, mutual learning and common development, and build a value dimension of common development. Promote the establishment of an innovation consortium with enterprises as the main body, in conjunction with universities and research institutions, to connect upstream and downstream, and to integrate industry and science and education to explore new models of production, education and research. By establishing cooperative relations and fully integrating the advantageous resources of all parties, it not only improves the quality of school personnel training, promotes the transformation of scientific and technological achievements, but also helps enterprises solve technical problems and enhance their core competitiveness. The direction of common development has been clarified, and there must be a sound institutional system to escort and form a deep integration innovation system with regional or industry characteristics. Promote regional economic and cultural construction at the macro level and deepen the drive for innovation, and at the micro level with deep integration of innovation to accelerate the solution of the development problems of the main bodies of industry, academia and research [9]: First, jointly promote the construction of a teaching practice system of multiple collaborative training in colleges and universities as soon as possible, and achieve the goal of building a "practice education community". Second, attach importance to students' unique innovative thinking, fully combine theory and practice, and cultivate a correct view of creativity and creativity for lifelong development. Third, attach importance to the important supporting role of senior talents in enterprises and industries in teaching and scientific research in colleges and universities, and implement the complementarity of production and education. Fourth, attach importance to the integration of the particularity of regional or industry development and the construction and development of the characteristic disciplines and majors of colleges and universities.

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4.5 Establish a Joint Talent Training Mechanism

From industry-university-research collaborative innovation to deep integration, higher education has shifted from “closed” to “open”, integrating explicit or implicit educational resources to form a resource advantage force. Actively integrate into economic and social development, break the conventional innovative education model, promote innovation and change in universities and enterprises, and integrate multiple parties to create new technologies, new methods, and new ideas to achieve a win-win situation [10]. From the collaborative innovation of industry-university-research institutes to in-depth integration, it will gradually build an industry-university-research cooperation base that integrates "higher education parks, science and technology parks, and incubation parks", and an open and sharing platform that gathers the three major resources of "teaching resources, industry-university-research cooperation, and public services". The government, enterprises and colleges and universities work closely together to establish a joint talent training mechanism, and form a number of double-qualified teacher teams composed of government, enterprise and school personnel. Deeply promote the school-enterprise collaborative education model, deepen the reform of "introducing enterprises into education", encourage enterprise technical personnel to implement practical education in schools, and support teachers to take temporary jobs in enterprises. On the basis of previous order-based training, on-the-job practice and co-construction of training bases, enterprises are encouraged to participate in school management and student training. Schools should actively try to innovate teaching models to solve the dilemma of talent training. Schools and enterprises jointly formulate teaching plans, jointly set up teacher teams, share teaching resources, and jointly establish a joint talent training mechanism. In order to realize the in-depth aggregation and integration of high-quality educational resources, build an industry-university-research cooperation platform with "schools as the mainstay, government promotion, industry leadership, enterprise participation, and common development" to promote industry-education collaborative education.

5. Conclusions

From industry-university-research collaborative innovation to deep integration is a complex process and systematic project. Only the coordinated operation between the participating subjects and elements can ensure the benign interaction of collaborative innovation. By building a new efficient and orderly operation mechanism, we will promote the transformation of various innovation entities from decentralized, block-like, and independent to centralized, orderly, and deeply integrated, carry out in-depth cooperation, and establish an all-round collaborative innovation cultural atmosphere.

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