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Industry-University Synergy From the Perspective of Knowledge Complementation: Drives and Roles

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***Abstract*—Industry-university synergy originates from the knowledge distance between universities and industrial enterprises, and meanwhile become feasible because of the complementarity of knowledge. In the process of industry-university collaboration, universities take the role of the source and supplier of abundant knowledge, while enterprises demand for knowledge and hold the leading position of technology innovation in practice. When the supply and demand of knowledge get matched and both sides have the intention of win-win cooperation, industry-university synergy will come true. The main ways, by which universities export knowledge to industries, are talents cultivation, technology transfer, and collaboration with enterprises on specific research projects, that is to say, providing potential qualified workforce and research achievements. Enterprises not only urge universities to conquer the cutting-edge or unsolved technology problems, but also employ skilled university graduate students, collaborate with professionals of universities and even commercialize the knowledge outcomes obtained from universities so that they may gain competitive advantages of sustainable technology innovation. In sum, industry-university synergy does good to boost the innovation development of universities and industrial enterprises through knowledge complementation.**

Keywords: industry-university synergy, technology innovation, collaboration, knowledge complementation

I. INTRODUCTION

The relations of university, industry and government are often discussed in the studies about innovation and knowledge production in science and technology [1][2]. In general, industrial enterprises mainly focus on technology innovation and knowledge application. Universities focus on disseminating knowledge and cultivating high-quality talents while engaging in scientific innovation and knowledge transfer. Through collaboration with universities, industrial enterprises can acquire new knowledge resources, and then absorb, internalize and apply the knowledge to promote sustainable innovation. As the collaborative partner with industrial enterprises, universities have strong scientific research capabilities, hold great advantages of basic academic disciplines and professional knowledge body, and provided most of the impetus for improvement of enterprises' innovation ability [3]. Therefore, industry-university synergy is the important way of knowledge transfer and knowledge spillover from universities to enterprises [4].

The essence of industry-university synergy is knowledge sharing, through which industrial enterprises aim to obtain knowledge spillover effect so as to reduce R&D and transaction costs [5][6]. Universities, driven by the industry's demand for cutting-edge knowledge and technology, accelerate the progress and depth of basic research, so as to consolidate the strength of universities, keep up with demand of the times, take the lead of disciplines development and enhance the academic reputation. Establishment of trustful collaborative relationships between university and industrial enterprises helps to transfer knowledge, boost innovativeness and address the challenges owing to technology rich environment and intensive market competition. Industry-university collaborative innovation is increasingly important, and cooperation between industry and university has already been taken as a crucial way of knowledge synergy [7]. Therefore, industry-university synergy is not only a win-win choice for both universities and industrial enterprises, but also an enabler for enterprises to innovate.

II. DRIVES OF INDUSTRY-UNIVERSITY SYNERGY: KNOWLEDGE DISTANCE AND COMPLEMENTATION

Enterprises are the users of knowledge, leading and dominating industrialization of scientific and technological achievements. As providers of knowledge, universities play a vital role in regional entrepreneurship and innovation activities, especially in technology transfer and commercialization[8] [9]. Cooperation between industry enterprises and universities on R&D projects and their joint innovation have been great sources of innovation[10]. As for industry-university synergy, universities are the suppliers of knowledge and enterprises are the demanders of knowledge. Enterprises obtain innovative knowledge from the suppliers (universities) through knowledge spillover mechanisms such as talent workforce flow, technical exchange, cooperative R&D and informal communication.

The complementarity and availability of knowledge resources are the foundation of synergy between industrial enterprises and universities. Due to the difference of knowledge inventory and knowledge body between universities and industrial enterprises, knowledge transfer and innovation

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can be realized through knowledge spillover from knowledge sources, knowledge transmission and diffusion, knowledge absorption and re-innovation by receivers. In the overwhelming knowledge competition, industrial enterprises are eager for advanced scientific and technological knowledge and specialized talents. Therefore, it's natural to issue a request to universities for the knowledge and skilled workforce. That is to say, a close matching of talented workforce and cutting-edge knowledge supply by universities to the knowledge demands of industrial enterprises, is required, to reduce the knowledge distance and build a bridge of knowledge complementation through industry-university synergy (see Fig. 1).

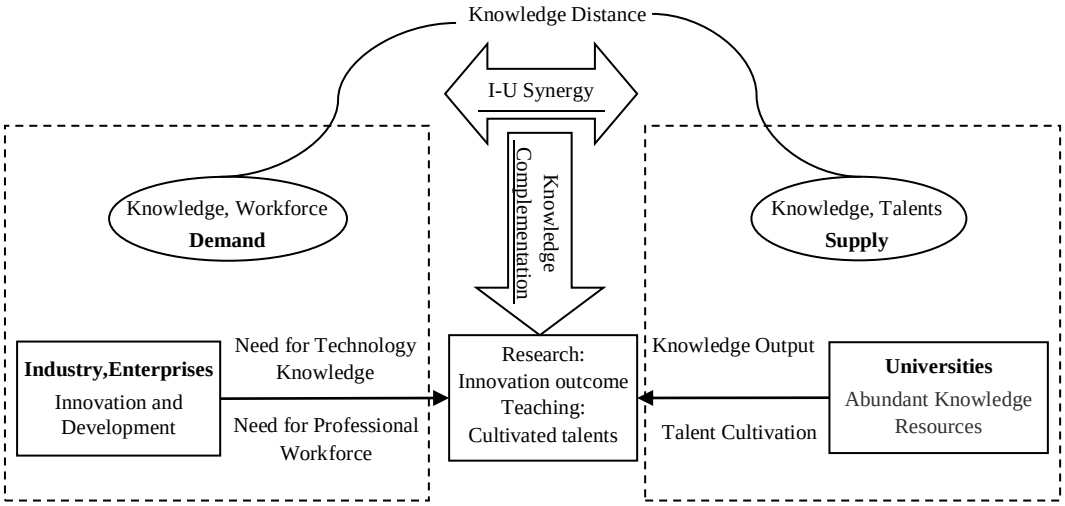

Fig. 1. Industry-university synergy and ways of knowledge complementation.

As shown in Fig. 1, on the one hand, the development of industrial enterprises has a great demand for advanced knowledge and professional talents. From the view of social level, the comprehensive development requires a large reservoir of scientific and technological knowledge; From the perspective of industrial enterprise level, it is necessary to hold professional knowledge and qualified workforce to engage in production and operation activities. In order to meet the challenges and maintain the competitiveness, newly advanced knowledge must be continuously imported and internalized to realize knowledge complementation and possess the cutting-edge applicable technology.

On the other hand, with its strong scientific research team and complete discipline system, universities have unique knowledge advantages and can continuously enrich knowledge resources through teaching, research and other academic activities. Universities can not only expand the field of disciplinary knowledge in breadth and depth, but also specialize in cultivating intellectual elite with cutting-edge knowledge which meet the needs of industrial development. Therefore, the capability of cultivating skilled talents and creating innovative knowledge makes universities occupy an important position in knowledge supply.

Thus, one side (the industry) has the knowledge demand, the other side (the university) has the knowledge supply, and it easily comes to an agreement on the mutual exchange of knowledge and the collaboration between universities and industrial enterprises.

However, the essence of industry-university synergy is knowledge synergy, which means to dynamically integrate knowledge resources of industrial enterprises and universities in a collaborative environment. By matching and coupling internal and external technological knowledge resources of the organization, industry-university synergy takes knowledge or technological innovation as the ultimate aim [11][12]. It devotes to obtain the knowledge synergetic effect among multiple subjects and multiple objectives [13] and to make up for the gap of knowledge demand and solve technological problems.

III. Roles in Industry-University Synergy

In general, enterprises and universities take various modes of collaboration to establish a symbiotic relationship in order to achieve industry-university synergetic innovation.

The modes of industry-university collaboration can be divided into different types from different views. From the perspective of knowledge flow, there are three types: knowledge transfer, knowledge sharing and knowledge creation. From the view of contractual relationship, four types are discovered: technology transfer, commissioned R&D, joint development and R&D alliance entity. As for the enterprises, a direct impact on their success of the collaboration activities with universities, is exerted by some factors: government policies, environmental support, (technical) knowledge absorption capacity, the degree of industry-university synergy and the adopted mode of industry-university collaboration. In other words, the knowledge coupling, ability matching, knowledge sharing, and willingness and behavior of synergetic innovation will determine the innovation effect of industry-university collaboration. Therefore, it’s necessary to analyze

the roles of universities and industrial enterprises in the evolutionary process of industry-university synergy.

A. The Role of Universities: Source of Knowledge Innovation

The University's role has achieved a rapid expansion in economic development in decades[14]. In the practice of industry-university collaboration, universities bear the responsibility of knowledge innovation and qualified talent supply. Universities improve the knowledge increment through research activities and meet the industrial needs for talents by teaching, which consist of the basic missions of universities, and hence provide the strong intellectual support and the talent guarantee for innovative industries. While performing their basic functions, universities can provide industrial enterprises with a continuous supply of talents and knowledge outcomes. Taken insight into academic activities and practical research processes of universities, their essence is knowledge creation, processing and transfer.

As one of the knowledge subjects in industry-university synergy, universities act as the source of knowledge and the supplier of professional talents: not only to create new knowledge and develop new technology, but also effectively promote diffusion of knowledge, information and technology, which gives knowledge support to industrial enterprises and their technology innovation. It could be understood from two aspects:

1) As a knowledge source and an education provider, universities create and disseminate knowledge through research and teaching activities, and provide systematic knowledge bodies for industrial enterprises. Universities not only cultivate students to be professional talents for the potential workforce of enterprises, but also provide scientific and technological knowledge to be the theoretical basis for enterprises' R&D, and furthermore engage in practical innovations through taking in charge of concrete research projects committed by enterprises. During such processes of knowledge-related activities and collaboration with enterprises, universities help to integrate innovative resources, urge to make innovation outcomes industrialized, and achieve positive synergetic effects due to industry-university collaboration.

2) Universities act as the most important source of public innovation support for industrial enterprises. On the one hand, universities have knowledge advantages and are eager to establish partnerships with enterprises. If are available the appropriate opportunities for collaboration between universities and industrial enterprises, there is great potential to create technological knowledge and earn more innovation space for enterprises' production. Meanwhile, to some small and medium-sized enterprises that are weak in R&D and short of independent innovation capability, universities can export their technological innovation results and convert them into new products or improve the existing technological level of SEMs. Through industry-university collaboration, universities' knowledge supply and enterprises' demand are well matched on the basis of knowledge resource complementation, and are realized the effective flow and optimized allocation of innovative resources between universities and industries.

B. The Role of Industril Enterprises:Leading the Technology Innovation Practice

Industrial enterprises act as the focal point of technological impetus, market pull and other innovative environmental influences. All these impacts drive enterprises to gain more forces to combine entrepreneur's creativity and initiative and engage in technological innovations. Under the condition of the market economy, enterprises naturally have the attribute of innovation, and have the quite close connection with the market; hence, they are capable to discover the application opportunities and identify the prospects of technological innovation.

Meanwhile, technical knowledge resources are essential basic resources to enhance the innovation level of industrial enterprises. Only if enterprises acquire new technologies or products and have the ability of continuous innovation, can they survive and develop greatly.

Therefore, enterprises take the leading role of technological innovation in the strict sense. Enterprises create and utilize knowledge in production practice and economic activities[15]. Through industry-university cooperation, enterprises cooperate with university researchers in the form of science and technology planning projects or commissioned projects to make up for the shortage of their knowledge resources. Enterprises can also internalize the innovative achievements made by universities and commercialize them so as to make new products, obtain economic benefits, and strengthen competitive advantages of enterprises.

In sum, industry-university collaboration promotes knowledge synergy and technology development between universities and industries. Enterprises and universities take the complementarity of knowledge resources and the win-win benefits as an opportunity to get in collaboration, establish a close cooperative relationship, engage in knowledge transfer and industrialization of technological achievements, and ultimately promote the technological innovation of enterprises and sustainable development of industries.

IV. CONCLUSIONS

It requires to strengthen enterprises' position of innovation subject, promote universities' reform of talent cultivation, and urge the knowledge coupling between the supply side (universities) and the demand side (enterprises) through industry-university synergy. Some conclusions and suggestions are given as follow:

1) To pay attention to the influence of industry development on higher education of universities, and improve the fitness between universities and industrial enterprises from the perspective of knowledge coupling. The system of higher education and professional workforce cultivation is required to be adaptive to industry development, and aims to foster problem-oriented knowledge professionals and innovative talents who are qualified for enterprises' positions.

2) To take industry-university synergy as an effective way to promote the integration of human capital with national

strategic goals, industrial development and knowledge resource endowment. In terms of the supply of knowledge-based talents, universities should explore talent cultivation modes that meet challenges of the industrial chain and help to get an accurate match between the knowledge supply and demand, so as to improve the efficiency of human capital investment.

3) To effectively integrate the knowledge resources endowment belonging to enterprises and universities. The main patters of industry-university synergy are qualified talent output by universities and R&D collaboration between universities and industrial enterprises. However, universities and enterprises are quite different and independent organizations with quite different value orientation and benefit demand. In order to achieve win-win results in the process of industry-university synergy, enterprises should enhance cooperative impetus and responsibility consciousness, and trustfully place the original beginning of human resources chain and innovation chain in universities; while universities improve cooperative willing and knowledge service capability. Both sides make joint efforts to boost the development of universities and industries.

In sum, industrial enterprises can fully rely on the knowledge resources and foundation of universities, take on skilled workforce training and R&D cooperation with them in order to achieve synergetic effect, which helps enterprises to integrate professional knowledge and technological talents from inter- and extern-organization. Thus enterprises may break through the bottleneck of crucial technology, upgrade business units, make technology and management innovations, and further make great progresses and earn the leading position in the furiously competitive market.

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