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Research on the Influence of Technological Diversity on Patent Transformation in Chinese Universities ---Regulatory Role of Technology Transfer Center

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Abstract— *Colleges and universities are the most concentrated places of scientific and technological achievements in a country, and they are also the main body of scientific and technological innovation. It is an important step in the transfer and transformation of scientific and technological achievements to effectively "transform" University patents. This paper studies the influence of technological diversity on University Patent Transformation from the perspective of technological attribute of patent itself, and considers the two kinds of knowledge flow formed in the process of patent transformation, and explores the countermeasures to enhance university patent transformation from the perspective of technology demand of enterprises, so as to provide reference for the development of University Patent Transformation and the construction of "industry university research and application" collaborative innovation system.*

Keywords— *Technology diversity, Patent transformation, Technology transfer center.*

I. INTRODUCTION

With the increasingly dynamic competitive environment, rapid technological updating and collaborative innovation, enterprises need to integrate diversified technologies to develop new product R&D and manufacturing, so as to cope with the challenges brought by multi technology products, complex process and accelerated new product upgrading, so as to gain competitive advantage by increasing the uniqueness and diversity of products. This requires that the innovation process of enterprises need sufficient technical support and highly diversified technical knowledge base. Technological diversity can bring heterogeneous knowledge to enterprises, enrich the technical knowledge base of enterprises, prevent enterprises from falling into path dependence, reduce capacity rigidity, and increase the technical capacity of enterprises. Technology introduction is an important starting point for independent innovation of enterprises. By embedding the digestion and absorption of patents purchased from colleges and universities into the process of independent research and development, enterprises can effectively complete the digestion and absorption of introduced technologies and enhance their technological capabilities.

With the increasing investment in science and technology, the number of University patents is growing rapidly. However, the transformation of university patent technology to enterprises is not satisfactory. According to the statistics of China's technology contracts in 2018, the turnover of China's technology contracts reached 1342.42 billion yuan, accounting for only 352.42% of the total. Although Chinese universities have made great progress in patent application and patent authorization, the patent conversion efficiency of Chinese universities is still low. In 2017, the average annual patent conversion rate of universities directly under the Ministry of education was less than 5%.

The digestion and absorption of new technology by enterprises is the final link in the process of patent transformation in Colleges and universities. Enterprises need patents with high degree of technological diversity to provide technical support for their own technological innovation. However, with the high number of University patents, the turnover of technology contracts and the number of patents sold have not increased significantly. Is it because the patents produced by universities cannot meet the needs of enterprises for technological diversity?

In addition, the transformation of university patent depends not only on the patent itself, but also on the ability of internal resource integration, technology management and service. As an important internal resource integration organization, University Technology Transfer Center has become an important driving force of patent technology transfer in research universities[1]. Technology transfer center is a place to realize the docking of technology information supply and demand, but technology cannot be directly traded. The process of patent commercialization in universities requires technology transfer center to promote the development of various universities through technology management and service In order to promote the transfer of patent technology, it is necessary to strengthen the interaction and information exchange between universities and enterprises. Therefore, this paper puts forward the following research questions: will technological diversity affect the patent transformation of Chinese universities? What is the regulatory role of technology transfer center?

The conceptual framework of this paper is as follows:

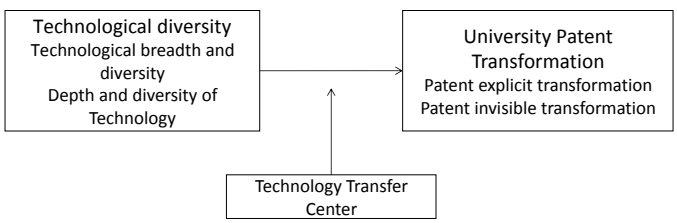

Fig. 1. The conceptual framework of this paper

II. THEORETICAL BASIS

The knowledge-based view holds that knowledge, as a resource, is the basis for the existence and development of an enterprise. The invisible knowledge in an enterprise is the main source of the core competence of an enterprise. In essence, an enterprise is a knowledge processing system, which exists as a collection of knowledge. Knowledge base is the collection of all kinds of knowledge elements owned by enterprises, including industry development knowledge, professional technology knowledge, product professional knowledge, market demand knowledge, etc. All kinds of activities of enterprises are carried out around knowledge acquisition, knowledge accumulation, knowledge integration and knowledge utilization. The process of enterprise knowledge management is the process of knowledge identification, acquisition, accumulation, integration, absorption, innovation and diffusion. There are similarities between knowledge production and knowledge management in enterprises and universities. Universities are divided into research groups that operate like enterprises. The difference is that universities lack a direct profit motive, which makes them become companies[2]. Ahuja and Katila believe that patent is actually a unique and novel knowledge element, and patent combination is a collection of abstract and non simulated knowledge elements[3]. Therefore, the patents produced by University researchers are the knowledge they create. Therefore, the diversity of technological knowledge base reflects the level of knowledge diversity of an organization to a certain extent, and the degree of technological diversity of patents reflects the distribution of knowledge resources contained in patents in different fields.

Knowledge transfer believes that enterprises can accumulate a large number of cross-border knowledge through international technology transfer[4]. It refers to the knowledge sharing across boundaries within or among organizations, that is, the transfer or transmission of knowledge between different organizations or individuals in different ways, or the transfer or transmission of knowledge between different organizations or individuals[5]. As the main body of knowledge production, colleges and universities increasingly need to transform the results of knowledge production effectively through knowledge transfer, so as to realize the value of knowledge innovation. Many scholars study university knowledge transfer from the perspective of technology transfer. Technology depends on a series of processes and products. The transfer and diffusion of technology is not only the transfer and diffusion of technology products, but also the application of knowledge. Therefore, when a technology product is transferred or diffused, the knowledge that constitutes it is also transferred and diffused. The two are inseparable. Technology transfer is a part of knowledge creation and application system. Technology transfer from university to enterprise includes two processes: one is the transfer from basic and general knowledge to application and specific knowledge; the other is the transfer from public knowledge to private knowledge.

The complexity of technology is gradually increasing, a technology often contains a high density of knowledge content, with the characteristics of interdisciplinary and interdisciplinary cross synthesis. Transferring the knowledge, technology and achievements created by colleges and universities to the society and business, completing the flow and application of college knowledge and realizing its market value is actually the problem of knowledge transfer in Colleges and universities. The technology and patent transformation owned by University patents can be regarded as a specific evolving knowledge form.

From the perspective of technological innovation, as the production base and communication center of new knowledge, the depth and breadth of innovation of colleges and universities are irreplaceable by any other organization. As the most important part of the national innovation system, colleges and universities have strong scientific and technological strength, but also have the advantage of talents, so colleges and universities can be used as the base of knowledge innovation and technological innovation, and become the source of new knowledge and new technology. Without the technical support of colleges and universities, it is difficult for enterprises to carry out high-yield technological innovation activities. At the same time, the demand of enterprises should also be the driving force of technological innovation in Colleges and universities. Whether the technological innovation activities of colleges and universities are successful depends on whether their patent achievements can be effectively transformed, whether they can meet the needs of enterprises, and whether they can be successfully transformed into productive forces.

III. LITERATURE REVIEW

A. *Patent Transformation*

Patent transformation is a dynamic process in which patent technology plays a role of economic attribute based on its technical attribute. It is also a process in which patent technology achievements flow and evolve among different subjects. At the same time, patent transformation is also a multi-stage and continuous process. Because of the complexity of the process, the realization of patent transformation needs the cooperation of multiple subjects. In practice, patent transformation closely relies on universities, research institutes, enterprises, governments and intermediary agencies. In this paper, patent transformation is defined as: Taking patent as the object, through the further application and promotion, technology, product and commercialization of the transformation subject, taking application as the purpose, making full use of the technical points disclosed in patent documents, and finally transforming patent into real productivity.

Patent transformation in Colleges and universities refers to the whole process that colleges and universities make full use of their own conditions, give full play to the advantages of science and technology, and carry out the experimental development, application and promotion of the valuable patents they have created, until the formation of new processes or new products. This study believes that the University Patent Transformation refers to the process of transforming the

university patent technology into real productivity after a series of subsequent research, development and experiments.

B. Technological Diversity

The concept of technological diversity can be traced back to Nelson's overview of knowledge diversity. Nelson found that if an enterprise has a broader technological knowledge base, its enterprise performance will be relatively improved[6]. However, Kodama was the first one to define technological diversity. He believed that technological diversity is the R&D activities outside the leading products of enterprises, and the activities of enterprises can be extended to other technological fields[7]. The formal proposal of technological diversity has aroused widespread concern. Scholars define technological diversity from different perspectives. With the deepening of the research, the definition of technological diversity has also appeared a trend of diversification. Technological diversity is the extent of patent application in the field of core technology, which means that an enterprise has three or more technological capabilities. The diversity of enterprise technology is the concentrated embodiment of the process and result of the expansion of enterprise technology knowledge base field, and emphasizes that the realization of enterprise technology diversity depends on the organic combination and coordination of enterprise internal and external technology resources[8]. Technology diversity refers to the expansion of knowledge base to multiple technology fields through internal R&D, external technology cooperation or technology merger and acquisition, which represents the broadening of the scope of technology knowledge fields owned or involved by enterprises[9]. Technology diversity refers to the extension of enterprise technology activities to the field of new technology, which indicates the expansion of enterprise technology base. Its formation and development is a process of knowledge accumulation. Therefore, there are two definitions of technological diversity: one is the multiple use of technology, which strengthens the added value of existing products, and promotes the promotion of products through a widely used technology; the other is the diversity of R&D activities, which carries out R&D activities in a broader scope and innovates a variety of technical knowledge.

China's exploration of technological diversity is relatively late. Technological diversity refers to the development of technological diversity of enterprises, which does not mean that enterprises weaken their existing core technological capabilities. Enterprises usually carry out research in the field of new technology on the premise of maintaining and improving their core technological capabilities. Especially in the context of the rapid development of science and technology and the increase of product complexity, enterprises tend to expand the scope of their own technology mining and exploration fields to maintain and strengthen their core technology capabilities. Technological diversity is the extension of enterprises in many other different technology fields besides the core technology fields, in order to achieve the technology field distribution suitable for enterprise development strategy A basic causal variable behind enterprise growth is an overall concept, which should examine the concentration degree of technology fields possessed by enterprises. Therefore, technological diversity is defined as the degree to which technological knowledge possessed by enterprises is dispersed in different technology fields.

According to the position relationship of enterprise technology in the industrial chain, this paper puts forward the vertical and horizontal technological diversity at the industrial level, and divides the technological diversity into broad technological diversity and narrow technological diversity. According to the relationship between new technology and core technology, some scholars divide technological diversity at the enterprise level into technological breadth diversity and technological depth diversity[10]. Technology breadth diversity refers to that the expansion of enterprise technology system takes place outside the core technology field of the enterprise, and expands the technology field of the enterprise to a broader field. Technology depth diversity refers to that the expansion of technology diversity takes place in the core technology field of the enterprise, and often takes place in the well-known technology field of the enterprise. When the scope of technology foundation is narrow, it can also obtain higher learning effect, it can play a positive role in knowledge transfer.

Therefore, in this study, technological diversity refers to the technological fields that university patents span. The degree of technological diversity can represent the innovation influence generated by the combination of diversified technologies, and technological diversity is divided into technological depth diversity and technological breadth diversity. The breadth and diversity of technology promote the technology base of colleges and universities to expand to a broader system scope, and obtain collaborative innovation from the cross integration of multiple technology fields; while the depth and diversity of technology promote the technology base to expand in the familiar core technology fields, so as to obtain higher innovation effect in the core fields that they are good at, increase the efficiency of knowledge transfer, and improve the innovation ability with lower cost power.

C. Technological Diversity and Patent Transformation in Colleges and Universities

Colleges and universities are the source of innovation and produce a large number of scientific and technological achievements every year. How to transform the scientific and technological achievements of colleges and universities into real productivity and improve the efficiency of scientific and technological investment is a common challenge faced by governments and colleges and universities all over the world. Only when the patent is commercialized can it bring real economic benefits to the patentee.

From the literature review, many scholars' researches on the influencing factors of university patent transformation mainly focus on the following aspects: first, there are many researches on the influence of Universities on university patent transformation. The overall level of scientific and technological achievements transformation performance of China's universities is not high, and the universities with strong scientific research strength, medical schools and the first batch of universities to join the National University Science and technology park have made great achievements in

scientific and technological achievements transformation In addition, the number of scientific research institutions has little correlation with the patent output of colleges and universities, and the number of subjects, scientific research personnel and scientific research funds have a significant impact on the patent output[11]. The transformation of scientific and technological achievements in Colleges and universities should strengthen the cooperation with the government and enterprises on the basis of self construction. In addition, the existing studies suggest that the problems in the transformation of scientific and technological achievements in Chinese universities include the lack of coherence in the transformation process, unclear goal orientation, and difficulty in docking scientific and technological achievements with enterprises.

Second, there are many studies on the impact of policies and environment on the patent transformation of universities. Economic development environment and enterprise demand are important factors affecting the efficiency of science and technology transformation of universities in China. Based on the RCV framework analysis, Wenning Jiang found that there is a large policy gap between the research and development (head) of frontier technology and the final commercialization (foot) of technology in universities, which must be solved through policy design The "relay" and "coordination" from scientific research and development to the final commercialization of achievements. Therefore, we should pay more attention to the organic coordination of the policy organization system for the transformation of scientific and technological achievements, vigorously promote the construction of innovation centers, science and technology industrial parks and other science and technology intermediary service institutions, and strengthen the science and technology intermediary policy, so as to break through the obstacles in the transformation of technology transfer and smoothly transform it into productivity. Foreign scholars have studied the influencing factors of university patent transformation. Industry development, incentive licensing mechanism and industrialization process all significantly affect the transformation of university scientific and technological achievements[12].

Third, there is little research on the impact of patent technical characteristics on university patent transformation, but high-quality patent is the foundation of patent transformation. When transforming patents, we should focus on the technical characteristics such as technical applicability, complexity and maturity. Some scholars have analyzed the four characteristics of patent technology, including the quality of patent technology, the maturity of patent technology, complementary assets, market and technological uncertainty, to study their impact on the selection of university patent transformation mode. Therefore, this paper studies the impact of technological diversity on University Patent Transformation from the perspective of the technical characteristics of patent itself.

From the literature review, many scholars did not distinguish the types of patent transformation, and calculated the transformation rate of scientific and technological achievements by using the number of patent applications or patent authorization as the denominator and the number of patents transferred and licensed as the numerator. In the process of R&D, University researchers promote the formation of two types of knowledge: one is the output of explicit knowledge, such as patents and papers, which can flow outside the university through citation, transfer, license and other explicit ways; the other is the cultivation of people's ability in the process of project R&D, which produces skilled knowledge and stores it in the minds of R&D personnel It cannot be measured directly. The accumulated and stored technical knowledge can be further returned to the form of explicit knowledge by means of R&D entrusted by enterprises or providing technical services, forming R&D achievements suitable for the needs of enterprises and flowing to the industry, so as to realize the contribution of university knowledge output to enterprise development and economic society.

The patent itself can be regarded as the knowledge output of colleges and universities. The technicality of patent includes not only tacit technical knowledge, but also explicit technical knowledge. Behind the patent transformation is actually the flow of knowledge. In the knowledge flow mode of colleges and universities, there are two main forms: one is the explicit knowledge flow of patent transfer and licensing, and the other is the entrusted development or the provision of technical services The flow of tacit knowledge.

Most of the research on technology diversity focuses on the enterprise level. Technology diversification was formally proposed by Kodama F. there are R&D activities outside the enterprise's leading products, which can be extended to other industries, that is, the enterprise's technology base can be extended to multiple technology fields, and the enterprise's knowledge growth can be promoted through internal R&D and external cooperation, so as to enhance the innovation ability[13]. However, whether the scope of technical knowledge contained in University patents will affect the transformation of University patents has not been fully studied. Some scholars have found that patents with diverse knowledge, high patent quality and wide technology range in Colleges and universities are more likely to be cited, which can also promote the process of patent commercialization in Colleges and universities[14]. The number of patent applications will have an impact on the flow of knowledge in specific technology areas in Colleges and universities, and the intensity of patent protection and technological diversity will also affect the value of University patents. The larger the technological scope of invention patents, the greater the possibility of their commercialization. These studies have proved that the diversification of patent technology in Colleges and universities will have a positive impact on their quality and commercialization.

The more diversified the technology of patent invention in universities, the more subsequent new patents will be generated, that is, the technological diversity can stimulate the generation of new patents[15]. There are also some studies that show that the wider the technological scope of a patent, the more alternative inventions that can be shielded by a patent

can be provided, and the more valuable a patent with a wider technological scope is to the patentee. Patents with diversified technologies can produce greater moderation and increase the value of patented inventions. Some similarities between the knowledge production of enterprises and universities are obvious. Although the internal organizational process of universities is relatively new and scattered[16], universities are divided into research groups that operate like enterprises. What they lack is a direct profit motive, which makes them become companies. Most of the literatures empirically study the positive effect of patent technology diversity of enterprises, but there are few studies on technology diversity at the university level, only mentioning the positive effect of technology diversity on patent quality and the relationship between technology diversity and patent commercialization.

D. Technology Transfer Center

Through technology management and service, university technology transfer center can promote the integration of various disciplines, strengthen the interaction and information exchange between universities and enterprises, and promote patent technology transfer. On the one hand, the university technology transfer center helps to build and maintain the R&D cooperation network, promote the integration of interdisciplinary, and provide protection for patents that produce technological diversity. On the other hand, the efficient technology transfer center can promote the patent transformation of colleges and universities. The university technology transfer center can help colleges and universities obtain important resources and professional knowledge from enterprises, which is conducive to the patent technology transformation[17]. University technology transfer center can overcome the obstacles of industry university cooperation, and has a positive correlation with patent authorization and patent transfer.

To sum up, the technology transfer center will not only help the integration of various disciplines and technology integration, but also affect the university patent transformation. Therefore, the above literature provides a good research support for this study to explore the regulatory role of technology transfer center in the impact of technology diversity on university patent transformation.

IV. Main Conclusions And Enlightenment

It enriches the related research on the influencing factors of university patent transformation. Many researches have been carried out on Patent Transformation in Colleges and universities at home and abroad. The problems of low efficiency of patent transformation in Colleges and universities and the difficulty of commercialization of scientific and technological achievements in Colleges and universities have been confirmed. The research on the influencing factors of patent transformation in Colleges and universities has also been carried out, mainly focusing on the influence of policies, environment and the main body of University Transformation on patent transformation There is little research on how the diversity of technology affects patent transformation. Therefore, in order to make up for the above gap, this paper analyzes the impact of technological diversity on university patent transformation, which provides a new perspective for the study of patent transformation.

From the perspective of the concept of patent application, this paper discusses the influence of the concept of patent application on the knowledge-based transformation. The degree of technological diversity of patents reflects the distribution of knowledge resources contained in patents in different fields. Therefore, by combing the theory of knowledge-based view, technological diversity refers to the degree of diversification of organizational knowledge base. This paper further discusses the impact of technological diversity on patent transformation, and expands the application of knowledge-based theory in patent transformation, which has certain theoretical significance.

Give full play to the advantages of colleges and universities, fully connect with enterprises, and complete the effective flow of resources. By studying the relationship between technological diversity and patent transformation in Colleges and universities, this paper helps colleges and universities and scientific research institutions recognize the role of technological diversity, help colleges and universities re-examine their own positioning, so as to effectively promote the transformation of scientific and technological achievements in Colleges and universities, fully dock with enterprises, and complete the effective flow of resources, so as to more effectively promote the transfer and commercialization of patent achievements in Colleges and universities to enterprises.

To enhance the efficiency of cooperation between Chinese universities and enterprises, and enhance the collaborative innovation of industry university research with enterprises as the main body. In the era of high requirements for innovation, enterprises not only need to have strong technology absorption capacity, but also need to actively feed back and communicate the trend of technology diversification to the technology transfer center of colleges and universities, so as to ensure that the research results of colleges and universities meet their own needs. Therefore, through the research on the influence of technological diversity on university patent transformation, we hope to make a useful exploration on the related research in the field of university patent transformation, better promote university patent, provide technical support for enterprises in R&D product level, and better promote the collaborative innovation of industry university research based on enterprises.

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