

A Study on the Law and Enlightenment of University-Enterprise Cooperative Patent in Yunnan Province

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ABSTRACT

Taking 32 undergraduate universities in Yunnan Province identified by the Ministry of Education as the research object, based on the patent data jointly applied by universities and enterprises in Yunnan Province from 2010 to 2018, this study started from the law between the total number of patents and the total number of university-enterprise cooperative patent, and deeply explored the spatial distribution and diachronic changes of university-enterprise cooperative patent. In terms of space cooperation, from the perspective of the number of participants in university-enterprise cooperation, Kunming University of Science and Technology ranked first among universities in Yunnan Province, and the number of patents applied for in cooperation reached 50.15% of the total amount of university-enterprise cooperation; in terms of diachronic changes, from 2015 to 2018, the growth trend of the total amount of patents was obvious, but the total amount of university-enterprise cooperative patents showed a fluctuating decline. The results would provide solid data support for the follow-up industry-university-research technical cooperation research in colleges and universities in Yunnan Province.

Keywords: *Yunnan Province; Undergraduate colleges; Patent; Cooperation Law*

1. INTRODUCTION

General Secretary Xi Jinping, in the report of the Nineteenth National Congress of the Communist Party of China, called for: "speed up the construction of first-class universities and first-class disciplines and realize the implicit development of higher education." [1] To carry out General Secretary Xi Jinping's educational thought, local colleges and universities are supposed to adhere to the integration of industry and education, deepen university-enterprise cooperation, practice their skills, speed up the transformation, and strive to take the road of implicit development of applied technology universities [2]. University is an essential subject of knowledge innovation and information diffusion, and occupies an important position in the national innovation system. The communication and cooperation between universities and enterprises, scientific research institutes and other colleges and universities form the driving force for the operation of industry-university-research cooperation network. A large number of scholars have shown that there exist broad common interests between higher education and industry. Those intensive enterprises are in the rapid development expected to obtain a lot of benefits from colleges and universities is what colleges and universities want to provide.

In recent years, it has been one of the important modes of

modern technology transfer that universities apply for patent license of scientific research and technological achievements to enterprises. With the continuous improvement of patent database, extensive scholars studied university-enterprise cooperative mode according to patent database to reveal the regularity of university-enterprise cooperative mode and study universities' position in regional economic development. Wen Fangfang [3] put forward various patent cooperative modes based on social relations, and revealed the laws of the university-enterprise studies in China, and found that university-enterprise cooperative mode was increasingly close; Zhang Heng et al. [5] investigated the network evolution of university-enterprise cooperative mode in Jiangsu Province, and concluded that the scale, frequency and density of university-enterprise cooperation in Jiangsu Province were increasing.

However, many types of research are focused on the whole country and the whole world, and there are few types of research on individual provinces. Due to the differences in the patterns of university-enterprise cooperation among different provinces, cities and universities, researchers are supposed to explore at a deeper level and conduct a more comprehensive and objective analysis. Based on the patent data published by the patent retrieval system of National Intellectual Property Administration, this study explored the temporal and spatial changes in the number of patents published jointly by universities and enterprises in Yunnan

Province in recent 10 years, which would deepen the understanding of the basic characteristics and laws of university-industry cooperation among universities, enterprises and even the government in Yunnan, and improve the efficiency and level of patent cooperation between universities and enterprises.

2. METHODS

2.1. Research Ideas

The patent data of 32 universities in Yunnan Province identified by the Ministry of Education from 2010 to 2019, which were published by National Intellectual Property Administration, were collected and analyzed. Then, it is necessary to study the law of the number of patents published from the two aspects of spatial distribution and diachronic change. Finally, according to the results of empirical analysis, it is able to carry out empirical summary and enlightenment.

2.2. Specific Methods

All the sample data needed in this study came from the patent retrieval system of the National Intellectual Property Administration, which contains all the Chinese patent data information since 1985. In this patent database, according to 32 undergraduate colleges and universities in Yunnan Province published by the Ministry of Education, all patent application information of each university was selected. Based on the data of patent license filing contract publicly registered by these universities and enterprises in the National Intellectual Property Administration, this study made an empirical study. First of all, this study selected 32 undergraduate universities by referring to the statistical yearbook database of Chinese universities and the information of undergraduate universities in Yunnan Province published by the Ministry of education; then using the patent retrieval system of the National Intellectual Property Administration, the patent licensing records of these universities as licensors in the National Intellectual Property Administration from January 1, 2010 to December 31, 2019 were collected. After searching the database of the National Intellectual Property Administration, the information of the patent license can be provided, including the patent name, patent application time, patentee, detailed address of the applicant, etc. Finally, according to the patent information disclosed by universities, this study judged the universities and regions to which the patent belongs, extracted the research sample data needed in this study from the original data and sorted them into an excel table, and carried out analysis and research on this basis.

The university-enterprise cooperative patent investigated in this study mainly selected the patent data whose patentees were universities and enterprises, and those whose names

were universities and enterprises in the patentees were regarded as the university-enterprise cooperation relationship. Because 13 of the 32 universities in Yunnan Province were not involved in university-enterprise cooperative patent, the final sample contained 1001 patent licensing records between 19 universities and 434 enterprises.

2.3. Data Processing

The time span of patent retrieval in this paper was 2010-2019, and the collection time was February 2020. The collected data (i.e., patent name, application date, inventor, patentee, applicant's address, school name) were unified and summarized in Excel. Due to the fact that it took about 18 months from invention to authorization, coupled with the delay in the database collection and processing process, the patent collection in the latest year was incomplete. We abandoned the patent sample data in 2019 and retained the open patent sample data from 2010 to 2018.

According to the statistics, several patents in the collected data had duplicate patents (i.e., one patent application had been published for many times) and the same family of patents. Therefore, the initial data cleaning and data deduplication were carried out on the sample data. In addition, the sample data was standardized, including the inventor specification, the patentee specification, the application date format specification and the applicant address specification. For the specification of patentees, when a patent contains three or more patentees, only the first two patentees will be retained. The reason for adopting this approach is mainly based on the following two considerations: first, the signature reflects the contribution rate. Generally speaking, the higher the signature, the greater the contribution [6]. Therefore, this article assumed that the first two patentees had contributed the most to the patent, and the cooperative relationship between them reflected their real research and development cooperation; second, considering the size of the number of samples, if all the patentees are studied, the number of samples is large, and the processing of data requires a lot of energy. According to the statistics of the sample, it was found that 88.42% of the cooperative patents were completed by two patentees, and only 11.76% of the cooperative patents were completed by three or more patentees. Thus it can be seen that if only the first two patentees are retained, the maximum capacity of the sample can be preserved in a limited time, and the data can be analyzed and processed to make the collected data more scientific and accurate. The application date was standardized, and only the year was selected for all patent application dates, which was convenient for the analysis of each year and reduced the difficulty of data processing. The total amount of original data collected in the State intellectual property Office was 30590. Through the processing of the above original data, the sample data of cooperation between universities and enterprises were selected, and 1001 valid sample data were obtained.

3. RESULTS

In recent years, research and development cooperation between universities and enterprises is a common phenomenon and there is often a certain law behind the phenomenon. In this study, through the statistics and summary of university-enterprise cooperative patents, we could understand the law of university-enterprise cooperation in a certain period of time, and understand its development trend. This study mainly analyzed the static and dynamic characteristics of university-enterprise cooperative mode (i.e., spatial distribution law and diachronic change law). The spatial distribution law refers to the change law of the university-enterprise cooperative patent in the spatial distribution in a certain period of time, and the diachronic change law refers to the law presented by the change of the university-enterprise cooperative

patent with time.

3.1. Spatial Distribution Law

This study took the patent data of 32 undergraduate universities published by Yunnan Province in National Intellectual Property Administration as samples, and 30590 items of original data were collected. By sorting out and counting the proportion of cooperative patents in the total sample, it was concluded that there were 1356 cooperative patents. The proportion of each part was shown in Fig. 1. The proportion of intra organizational cooperation was 56.75%, that of inter organizational cooperation was 13.24%, and that of independent research and development was 30.01%.

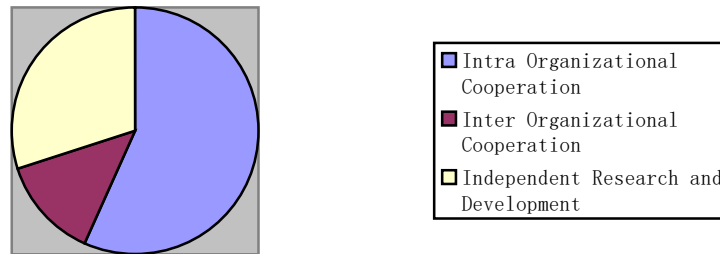


Figure 1. The proportion of various types of patents in the total sample

In the inter organizational cooperation, we divided the nature of cooperation into university-enterprise, university-university, university-scientific research institute and other four kinds of cooperative relationships. The distribution of various cooperation types was presented in Fig. 2. Among the inter-organizational cooperative modes, the proportion of university-enterprise cooperative mode was the highest, accounting for 69.13%, followed by the university-university, accounting for 10.91%, and the university-scientific research institute cooperative mode accounted for 10.64%. Besides, other cooperative modes accounted for 9.32%. From the statistics of the total sample data, it could be concluded that the university-enterprise

cooperative relationship accounted for the largest proportion of the total amount of inter-organizational cooperative patents, while the proportion of other cooperative relationships was the smallest. The total number of patents studied was 30590, and the number of university-enterprise cooperative patents was only 1001, so the university-enterprise cooperative relationship only accounted for 3.27% of the total patents. It could be concluded that from 2010 to 2018, the degree of inter-organizational cooperation of colleges and universities in Yunnan Province was low, and the sense of cooperation between universities and enterprises was weak.

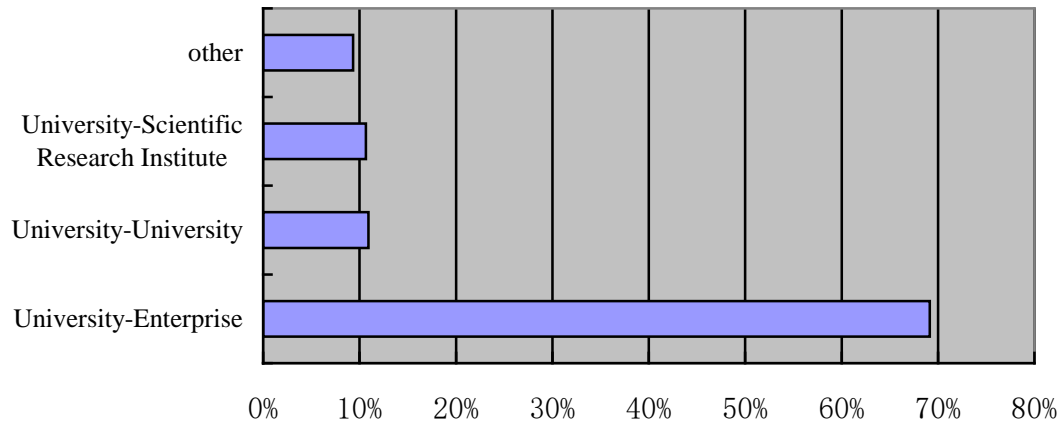


Figure 2. Cooperation type pattern proportion distribution

In terms of the number of participants in university-enterprise cooperation, there were 1001 university-enterprise cooperative patents in the sample data, involving 19 universities and 434 enterprises. As can be seen from Table 1, among the top 10 universities in Yunnan Province in the number of cooperative invention patents applied for by universities and enterprises from

2010 to 2018, eight universities were located in Kunming, and the proportion of the number of cooperative patents between universities and enterprises in these eight universities reached 93.31%. In addition, Kunming University of Science and Technology had the largest number of university-enterprise cooperative patents among the 32 universities, accounting for 50.15%.

Table 1. Top 10 university-enterprise cooperative patents of 32 universities in Yunnan Province from 2010 to 2018

University	Location	University-Enterprise Cooperative Patents Number	University-Enterprise Cooperative Patents Proportion
Kunming University of Science and Technology	Kunming City	502	50.15%
Yunnan Agricultural University	Kunming City	270	26.97%
Southwest Forestry University	Kunming City	55	5.49%
Yunnan University	Kunming City	48	4.80%
Kunming University	Kunming City	22	2.20%
Wenshan University	Zhuang-Miao Autonomous Prefecture of Wenshan	15	1.50%
Kunming Medical University	Kunming City	13	1.30%
Yuxi Normal University	Yuxi City	12	1.20%
Yunnan Normal University	Kunming City	12	1.20%
Yunnan University of Traditional Chinese Medicine	Kunming City	12	1.20%

To sum up, the participation of university-enterprise cooperative patents in 32 undergraduate universities in Yunnan Province was low, and the proportion of university-enterprise cooperative patents in the total sample was only 3.27%. As a result, it could be concluded that in the transfer of scientific research and technological achievements in colleges and universities in Yunnan Province, the foundation of university-enterprise cooperation was weak and the patent application was mainly published through intra-organizational cooperation. Additionally, the awareness of university-enterprise cooperative mode was relatively low. Only a few colleges and universities participate in the university-enterprise

cooperative mode, and the awareness of inter-organizational cooperative mode need to be strengthened. Among the colleges and universities in Yunnan Province, Kunming, as the main municipality of university-enterprise cooperative patent, had a good sense of university-enterprise cooperation, while other municipalities had relatively weak awareness of university-enterprise cooperative mode.

3.2. Diachronic Change Law

In order to further understand the changing trend of

university-enterprise cooperative patents, through the analysis and statistics of the total amount of patents and university-enterprise cooperative patents, the following charts were obtained. Tables 2 and 3 described the university-enterprise cooperative patent applications of colleges and universities in Yunnan Province from 2010 to 2018. In terms of the number of applications, from 2010 to 2013, it was at a low level, and the annual number of

cooperative patents was less than 70; from 2014 to 2015, it showed an upward trend, and the annual number of cooperative patents was more than 100; and from 2015 to 2018, it was in a state of fluctuating decline. Thus it could be seen that the number of university-enterprise cooperative patents of 32 undergraduate universities in Yunnan Province showed obvious three-stage characteristics.

Table 2. Publication of university-enterprise cooperative patents of 32 universities in Yunnan Province from 2010 to 2018

Year	Patents number	Year	Patents number
2010	41	2015	170
2011	59	2016	146
2012	45	2017	206
2013	65	2018	164
2014	105		

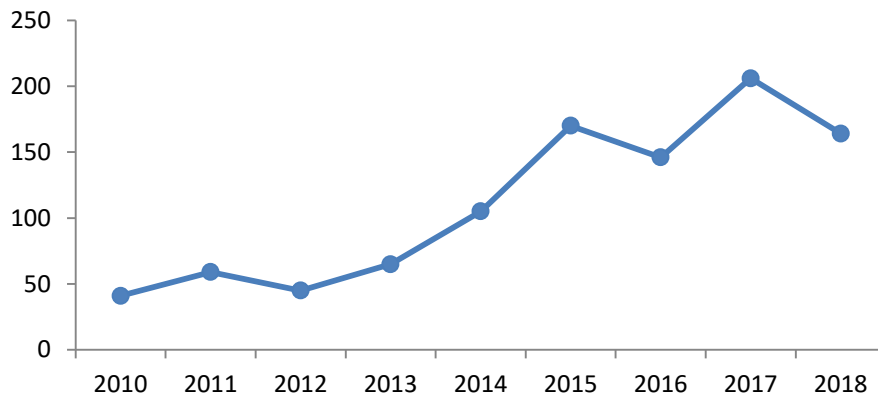


Figure 3. Patent situation of university-enterprise cooperation in different years

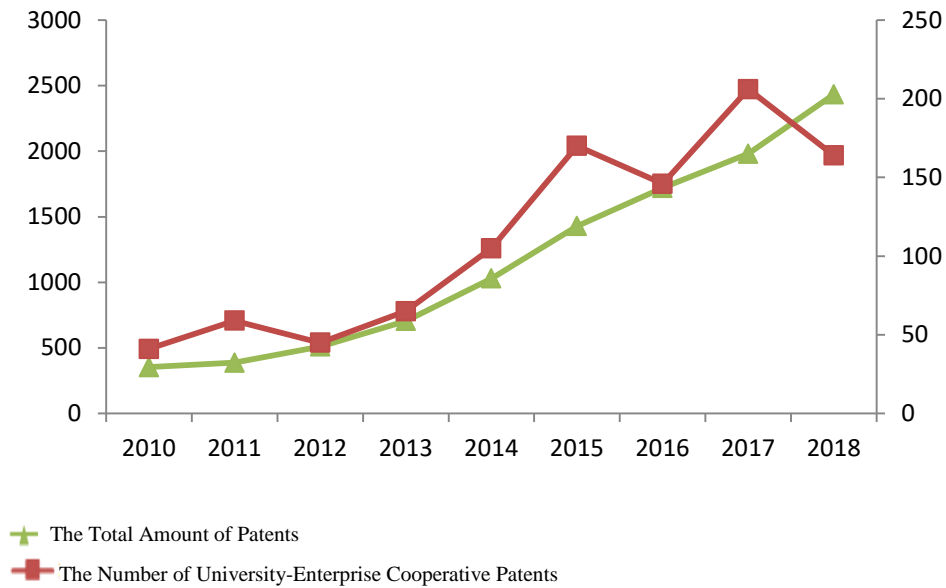


Figure 4. The diachronic change of the number of university-enterprise cooperative patents

The broken line chart of the comparison between the total number of patents and the total number of university-enterprise cooperative patents was presented as Fig. 4. According to the changes of the two curves in the figure, the development trend of the total number of patents published by colleges and universities and the total number of university-enterprise cooperative patents in Yunnan Province from 2010 to 2018 had the following stages: 1) from 2010 to 2012, the total number of patents increased relatively slowly, and the number of university-enterprise cooperative patents presented a slow rise stage and fluctuated; 2) from 2012 to 2015, the total number of patents and the number of university-enterprise cooperative patents showed a significant growth trend, and the growth rate of the number of university-enterprise cooperative patents was relatively obvious, slightly exceeding the growth rate of the total number of patents; 3) from 2015 to 2018, the growth trend of the total number of patents was obvious, but the number of university-enterprise cooperative patents showed a fluctuating downward state. From the above analysis, we can draw a conclusion that the university-enterprise cooperative mode showed an upward trend to a certain extent from 2010 to 2018. The total number of patents and the number of university-enterprise cooperative patents coincided in 2012 and 2016. In 2018, the total amount of university-enterprise cooperative patents was lower than the total number of patents published in that year, and showed irregular fluctuations after 2015, and the fluctuation range was relatively large. To sum up, it can be found that the university-enterprise cooperative mode was concerned by extensive universities and enterprises, showing a fluctuating upward trend. For a period of time in the future, the mode of university-enterprise cooperation will develop in a more stable and standardized direction.

4. CONCLUSIONS

Through the patent retrieval system of National Intellectual Property Administration, this study collected the patent data published in the patent database of colleges and universities in Yunnan Province from 2010 to 2018, made a quantitative and qualitative analysis of the data, and selected appropriate research methods to process the data. The following conclusions were drawn:

(1) Through the collation and statistics of the total sample data (30590 items), this study analyzed the total amount of patents published by colleges and universities in Yunnan Province and the distribution law of university-enterprise cooperative patents in time and space. In terms of spatial distribution, the number of patents for intra-organizational cooperation for inter-organizational cooperation was the largest, accounting for 56.75%, and the number of patents for inter-organizational cooperation was the lowest, accounting for 13.24%. Among the four types of inter-organizational cooperative patents, university-enterprise accounted for the largest proportion, but the proportion of university-enterprise cooperative patent in the total sample was only 3.27%. In terms of the

number of participants in the cooperation between universities and enterprises, Kunming University of Science and Technology ranked first among universities in Yunnan Province, and the number of patents applied for by the cooperation reached 50.15% of the total amount of cooperation between universities and enterprises. Generally speaking, the participation of colleges and universities in Yunnan Province in cooperation with enterprises in the transfer of scientific research achievements was low in 2010-2018, and many universities lacked the consciousness of cooperation with enterprises.

(2) According to the law of diachronic change, from 2010 to 2018, the development trend of the total amount of patents published by colleges and universities in Yunnan Province and the total amount of university-enterprise cooperative patents can be divided into three stages: in the first stage, from 2010 to 2012, the growth of total patents and university-enterprise cooperative patents was relatively slow; in the second stage, from 2012 to 2015, both of them showed an obvious growth trend, but the growth rate of the total amount of university-enterprise cooperative patents was relatively obvious, slightly exceeding the growth rate of the total amount of patents; in the third stage, from 2015 to 2018, the growth trend of the total amount of patents was obvious, but the total amount of university-enterprise cooperative patents showed a fluctuating decline. However, it showed an upward trend as a whole.

5. ENLIGHTENMENT

The empirical results and theoretical views of this study provide some substantive references for the universities in Yunnan Province whether to adopt exclusive licensing and formulate strategies to improve the effect of technology transfer in practice, to realize the market value of scientific research and technological achievements of universities in Yunnan Province.

(1) To realize the market value of scientific research achievements in Colleges and universities, it is necessary for colleges and enterprises to jointly invest complementary resources and cooperate to solve the challenges that may arise in various stages. Industry-university patent cooperation network is a mutually beneficial and win-win innovation ecological network for universities and enterprises. As the main body of knowledge spillover, universities hold international and domestic cutting-edge technology, while enterprises are the main body to improve innovation ability and patent output. When universities and enterprises cooperate closely, the two sides provide their own resources, work together for collaborative innovation, mutual benefit and win-win, which will improve the efficiency of scientific research transfer. Scientific research cooperation between universities and enterprises increases with the increase of years, and has gradually attracted more attention. Now it has become one of the important modes of scientific research and technology transfer.

(2) The reasonable contract designed by colleges and universities, with the help of exclusive licensing, can

promote the successful transformation of scientific and technological achievements. Through empirical analysis, it was revealed that the exclusive licensing strategy played an important role in improving the effectiveness of technology transfer in colleges and universities. On this basis, the influencing factors of exclusive licensing tendency were studied. Specifically, when an enterprise lacks the experience of university-enterprise cooperation, does not have the advantage of geographical proximity, and the scientific research technology is not mature, colleges and universities can encourage enterprises to invest in complementary resources, design and formulate reasonable contracts with the help of exclusive licensing strategies, and select "optimal" partners, to promote the successful transformation of scientific research and technological achievements of colleges and universities in Yunnan Province, and realize the market value of this scientific research technology.

ACKNOWLEDGMENT

This work was jointly funded by Yunnan Science and Technology Department and local colleges and universities-Research: on the Evolution of the Social Network Structure of Patent Transformation in Yunnan Province (Projects of the Year 2020).

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