

Analysis of Patents Awarded by Universities in China

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Abstract:

China Patent Award is the highest award for patents provided by the Chinese government, and the award-winning volume represents one of the essential symbols for evaluating the technological innovation capability and the knowledge transformation of technological inventions in universities. This paper makes a macro-analysis of the changes in Chinese universities awarded with China Patent Awards. We conducted a multi-dimensional analysis of the universities-awarded patents from the 1st to the 22nd China Patent Awards, including the distribution of quantity, geographical composition, attribute composition of awarded universities, patent legal status, and patent operation. The results show that the number of awarded patents of universities is accumulating; Beijing is the city with the highest number of awarded universities; Tsinghua University is the most awarded university; the number of First-Class Universities and National Intellectual Property Demonstration Colleges are more among the awarded universities, and the field of Part C (chemistry, metallurgy) is the most awarded IPC category. Universities are one of the main forces of China's scientific and technological innovation and play a leading and demonstration role in basic research and high-tech fields. The quantity and quality of universities' patents are regarding their own innovation capability and domestic and foreign core competition ability. It also reflects the active participation of universities in the national scientific and technological innovation system, thus influencing the direction of China's intellectual property strategy deployment and development.

Keywords: *China Patent Award, Universities, Intellectual property rights, Patent analysis.*

I. INTRODUCTION

Intellectual property protection can drive innovation and high-quality development, thus building a new evolutionary pattern of intellectual property relations. Currently, it related intellectual property protection to national security and economic security. Meanwhile, intellectual property is no longer a simple issue of legal, property, and innovation, nor is it a specific aspect of innovation-driven development. Instead, it is a comprehensive relationship between those aspects. At present, under the background of the new round of scientific and technological revolution and industrial transformation, we are urgent to accelerate the realization of high-level science and technology self-reliance and self-improvement globally. The Third Conference on Science and Technology held on May 28, 2021, in China, emphasized the historical mission of national laboratories, national research institutions, high-level research universities leading science and technology enterprises and put forward specific requirements for various aspects to

play their roles, realizing self-reliance and self-improvement of high-level science and technology, and especially universities should assume the responsibility.

In the research on the patents that have won the China Patent Awards in previous years, there are the macro-analysis of the patents awarded in the previous China Patent Awards [1] as well as the summary and analysis of the patents awarded from the 13th to 21st China Patent Awards [2]. Previous researchers summarized the characteristics of awarded patents of the China Patent Awards. It also discusses the research on the intellectual property service support in universities from the angle of information service in university libraries [3]. However, there are few studies focused on the macro-analysis of Chinese universities that won China Patent Awards.

As an essential part of the national innovation system, universities are the main battlefield for the cultivation of innovative talents, the main force for basic research, and the new force for major technological breakthroughs. Universities should fully understand the conditions and advantages of self-reliance in science and technology, strengthen their mission in achieving high-level self-reliance in science and technology, and provide strong support for serving the new evolutionary pattern and accelerating the construction of a strong country in science and technology. In this paper, we make a macro-analysis of the Chinese Patent Awards and multi-dimensional analysis of the patents awarded from the 1st to the 22nd of the China Patent Awards, including the quantity distribution, regional composition, attribute composition, patent legal status, and patent operation.

II. DATA SOURCE AND PROCESSING

2.1 Data Source

The data used in this study are public data, which are obtained from the China Intellectual Property Office (CNIPA) and the official website of the Chinese Ministry of Education. The publicly available lists of China Patent Award winners from the first session in 1989 to the 22nd session in 2021 and the lists of general universities, the top universities and the National Intellectual Property Pilot Colleges (NIPPC) or National Intellectual Property Demonstration College (NIPDC) from the Ministry of Education of China in 2021 were obtained, respectively. The data analysis was limited to invention and utility patents awarded by Chinese universities and did not involve design patents. The winning information used in the 22nd session is the list provided in the Pre-22nd China Patent Award published on October 12, 2021.

2.2 Data Processing

Download the list of winners for each session and screen out the universities that have won the China Patent Award, which ignores the applicant's ranking order, with the aim of extracting patents from all universities whose standardized original applicants are in line with the Ministry of Education's 2021 list of general universities (hereinafter referred to as "awarded universities"). During the extraction process, we

found that there are some universities applying for one patent together. Therefore, this type of patent will be counted once, namely, for the same patent, the awarded university will count once respectively.

Next, summarize and index the basic information of the universities, including the information of each university's provincial administrative unit, whether it is a top university, NIPPC or NIPDC, and winning time.

In this paper, the Patsnap patent database platform (<https://www.zhahuiya.com/>) is selected as the patent analysis tool. The indexed data will be put into the Patsnap patent database to analyze the patent information, including the application trend, legal status, patent implementation, patent license type, popular award fields. The popular awarded field analysis was based on IPC section.

III. ANALYSIS ON THE STATUS QUO OF CHINESE PATENT AWARDS IN UNIVERSITIES

3.1 Development Trend Analysis

Since the 1st China Patent Awards held in 1989, Chinese universities have won 681 Chinese Patent Awards and the total volume has increased, including 67 Gold Awards (65 Invention Patents and 2 Utility Patents), 85 Silver Awards (84 Invention Patents and 1 Utility Patents) and 529 Excellent Awards (524 Invention Patents and 5 Utility Patents), as shown in TABLE I. The awarded patent type of Chinese universities is mainly invention patents. According to the limitation on the quantity of invention Gold Award (20 pieces) and invention Silver Award (60 pieces) in the Measures for Awarding Chinese Patent Awards, the volume of university-awarded patents with Excellence Award is the largest according to the TABLE I, accounting for approximately 77% of the total patents volume university-awarded.

150 universities have awarded prizes, of which 78 are top universities (52% of the awarded universities), and 73 are neither NIPPC nor NIPDC (8.67% of the awarded universities), which is the second-largest volume after the top universities. Among the top universities, 25 NIPDC won the China Patent Award (38.46% of the number of top universities), among non-top universities, there are 50 neither NIPPC nor NIPDC (69.44% of the non-top universities), as shown in TABLE II and Figure 1.

TABLE I. Number and Type of the Chinese Patent Awards to Chinese Universities

Award Type		Invention Patents	Utility Patents
Gold	Qty/piece	65	2
	Proportion/%	9.54	0.29
Silver	Qty/piece	84	1
	Proportion/%	12.33	0.15
Excellent	Qty/piece	524	5
	Proportion/%	76.95	0.73

TABLE II. Detailed Statistics and Proportion of Awarded Universities

		Quantity/institute	Proportion/%
Nature	Awarded d universities	150	
	top universities	78	52.00
	NIPDC	30	20.00
	NIPPC	47	31.33
	neither NIPPC nor NIPDC	73	48.67
Top universities	NIDPC	30	38.46
	NIPPC	25	32.05
	neither NIPPC nor NIPDC	23	29.49
Non-Top universities	NIDPC	0	0.00
	NIPPC	22	30.56
	neither NIPPC nor NIPDC	50	69.44

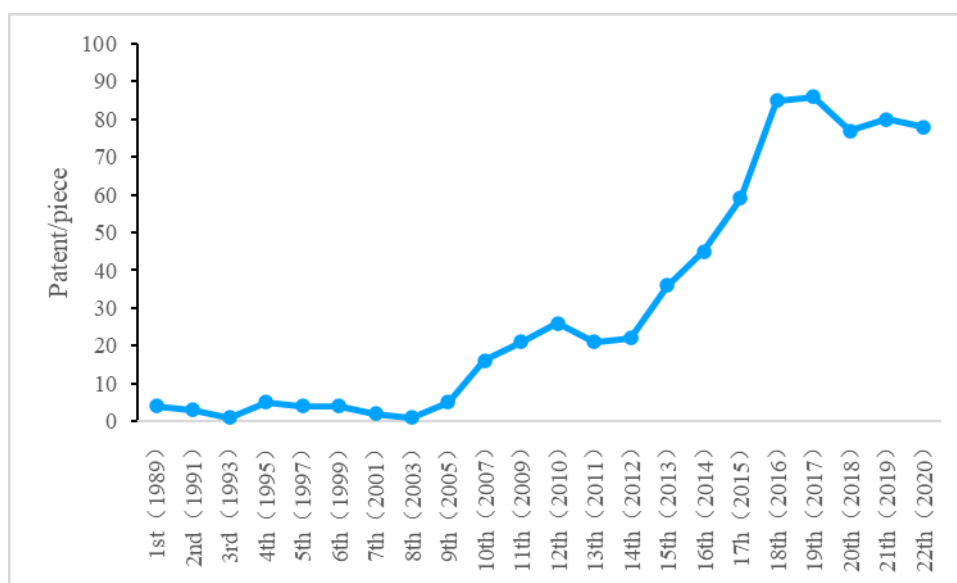


Figure 1 Trend of Number of awarded patent of the China Patent Awards in Chinese Universities

3.2 Regional Distribution of Awarded Universities

Among the 34 provincial administrative units in China, all but the Inner Mongolia Autonomous Region, Tibet Autonomous Region, Qinghai Province, China’s Taiwan, and China’s Macao have won the China Patent Award. Beijing and Jiangsu provinces received over 100 awards, while Guangdong and Zhejiang provinces received over 50. The most awarded region is Beijing, followed by the port cities of Jiangsu, Guangdong, Zhejiang, Shandong, Tianjin, and Shanghai, as shown in Figure 2.

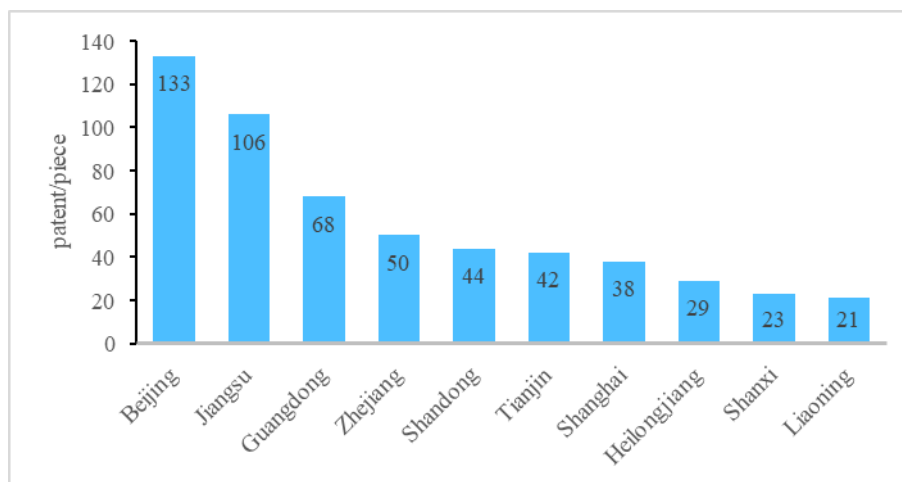


Figure 2 The TOP 10 regions of universities won the China Patent Awards

3.3 Analysis on the Awarded-Patents and Types of Awarded Universities

TABLE III shows the statistics on the number of universities' awarded-patents. Also, we summarized the awarded universities' location, whether they are the top universities and whether they are NIPPC or NIPDC. According to the TABLE III, there are 17 universities made the top 10, involving 11 provincial administrative units, including 13 top universities and 11 NIPDC. Tsinghua University is the most awarded university who have won 56 awards, the second is South China University of Technology who has won 15 awards, and the third is Tianjin University who won 30 awards.

TABLE III. Top 10 Ranking of awarded universities

Ranking	Name	No. of Awards/pieces	Provincial administrative unit	a top university (Yes/No)	NIPPC(P) or NIPDC(D)
1	Tsinghua University	56	Beijing Municipality	Yes	D
2	South China University of Technology	41	Guangdong Province	Yes	D
3	Tianjin University	30	Tianjin City	Yes	D
4	Zhejiang University	26	Zhejiang Province	Yes	D
5	Zhejiang University of Technology	19	Zhejiang Province	No	P
6	Harbin Institute of Technology	16	Heilongjiang Province	Yes	D
7	Dalian University	14	Liaoning	Yes	D

	of Technology		Province		
	Jiangnan University	14	Jiangsu Province	Yes	D
	Shanghai Jiao Tong University	14	Shanghai Municipality	Yes	D
	China University of Mining and Technology	14	Jiangsu Province	Yes	D
8	China University of Petroleum (Beijing)	13	Beijing Municipality	No	Neither
9	Jiangsu University	12	Jiangsu Province	No	P
	Xi'an Jiaotong University	12	Shaanxi Province	Yes	D
10	Peking University	10	Beijing Municipality	Yes	D
	Hohai University	10	Jiangsu Province	Yes	P
	China University of Petroleum (East China)	10	Shandong Province	No	Neither
	Huazhong University of Science and Technology	10	Hubei Province	Yes	Neither

3.4 Analysis of Legal Status of Awarded Patents in Chinses Universities

Next, we summarized the legal status of awarded patents along with the potential invalidity causes. An entitled patent refers to patents that have been granted and remain valid until retrieval and have not been abandoned, or expired terminated because of unpaid annual fees. Unauthorized patents include two types: 1) Authorized termination patents the expired patents that have been authorized and terminated by the date of retrieval due to abandonment, expiration of the term of protection, or failure to pay the annual fee, these expired patents become public technology. 2) Application for termination of patent, the patent application that has been made public and has been voluntarily withdrawn, deemed withdrawn, or rejected in the process of examination. These applications no longer have the possibility of authorization and become public technology.

Among the 681 patents awarded by universities in the TABLE IV, there are 521 valid patents and 520 authorized patents, accounting for 77% and 76% respectively. The 160 invalidated patents account for 23%, among which 135 patents have not been paid an annual fee (account for 84%).

TABLE IV. Legal Status and Legal Events of University Awarded Patents

Legal Status	Legal event	No. of Patent/piece	Percentage/%
Effective 521, 23.5%	Authorization	520	76.36
	Restoration of right	1	0.15
Failure 160, 76.5%	Unpaid annual fee	135	19.82
	Expiration of Term	23	3.38
	Application Termination	1	0.15
	Avoid duplication of authorization	1	0.15

3.5 Patent Operation of Awarded Chinese Universities

The patent operation model is divided into two patterns: single operation model and multiple operation models. Single operation model is a single way of operation such as transfer of patent right, patent license, or patent pledge; multiple operation models are the superposition of single operation models, such as transfer of patent right and patent license, transfer of patent right and patent license and pledge. Figure 3 shows that 94.9% of the 215 operating patents adopt a single patent operation model, and only 5.1% of the patents adopt multiple patent operation models. In the single operation model, 54% of the patents are transferred, namely, more than half of the patents have been transferred, 45% of the patents have been licensed, and no single model of patent pledge has been found.

Among the 215 patents awarded by universities for operation, 102 have been licensed, among which, the number of exclusive licenses is the largest, nearly 50%, and the general license and solo license account for about 50%, as shown in TABLE V.

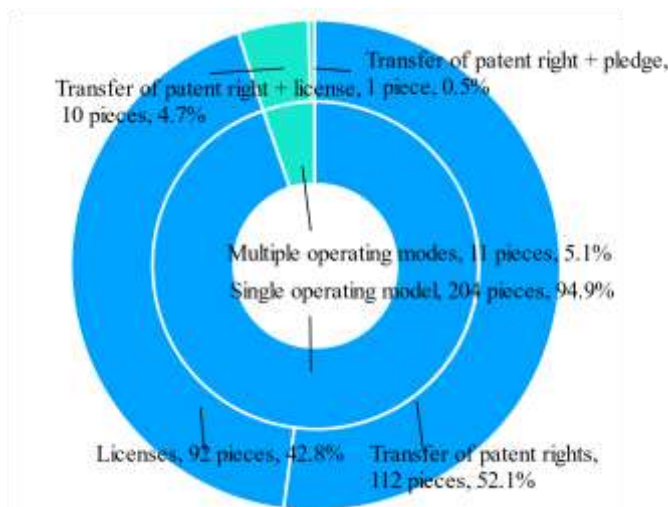


Figure 3 Operation of Awarded Patents in Chinese Universities

TABLE V. Types of Awarded Patent Licenses in Chinese Universities

License Type	Number of patents	Proportion/%
Exclusive License	50	49.02
General License	43	42.16
Solo License	9	8.82
Total	102	100

3.6 Research Field of Awarded Patents in Chinese Universities

According to the IPC (International Patent Classification) categories in the Table VI, Part C Section(chemistry and metallurgy) is the highest Section among the total number of patents awarded by universities, followed by Part G Section(physics) and Part B Section(operation and transportation), followed by Part H Section(electricity), Part A Section(necessary for human life), Part E Section(fixed buildings) and Part F Section(mechanical engineering, lighting, heating, weapons and blasting).

From the overall trend, figure 4 shows that Part C and Part A present a slow decreasing trend; Part G, Part B and Part H present a slow increase trend; Part F fluctuates greatly, and has absent the China Patent Award from the 5th to the 9th; Part D of Part E appears late, with Part E starting from the 12th, and Part D having won patents since the 11th.

Table VI. Partial categories of IPCs awarded by universities

IPC Classification Section Number	No. of Patent /piece	Proportion/%
C Chemistry; Metallurgy	235	34.51
G Physics	159	23.35
B Operations; Transportation	137	20.12

H Electrical	99	14.54
A Necessary for human life	65	9.54
E Fixed Building	49	7.20
F Mechanical Engineering; Lighting; Heating; Weapons; Blasting	43	6.31
D Textiles; Papermaking	17	2.50

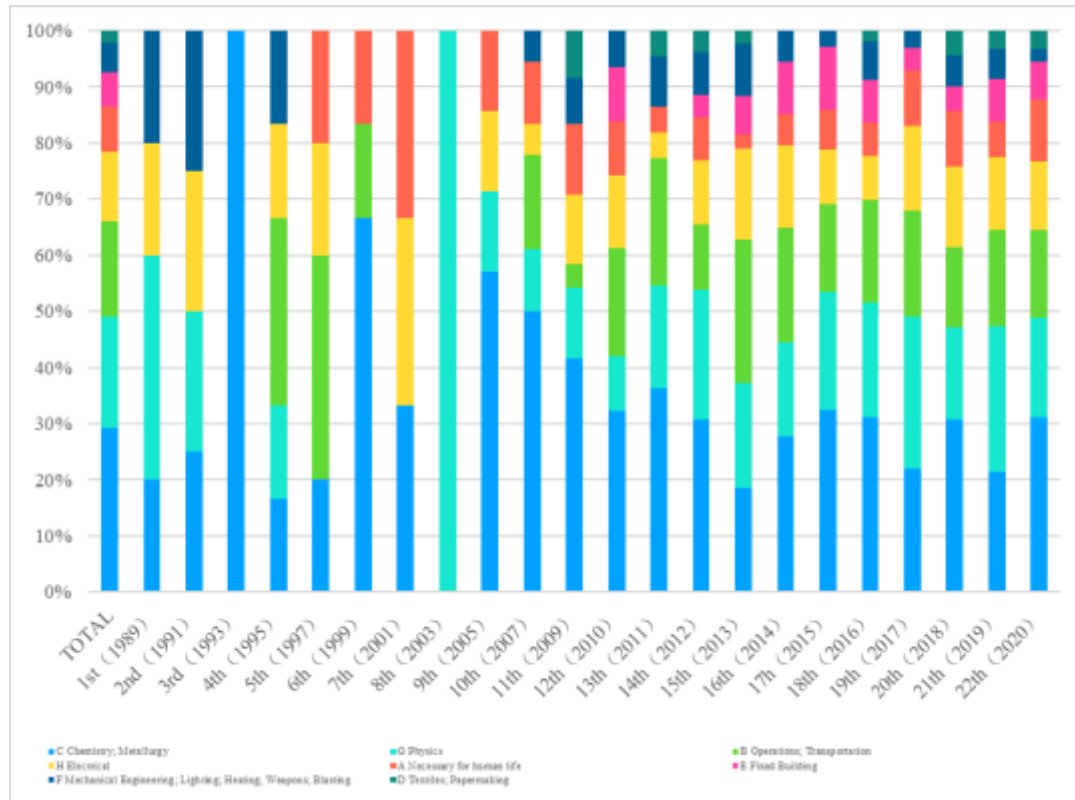


Figure 4 Trend of IPC categories' proportion of Patent Awards of the China Patent Awards in Chinese Universities

IV. SUMMARY

This paper makes a quantitative analysis of the patents awarded by Chinese universities from the 1st to the 22nd of the China Patent Awards. The total number of patents awarded by Chinese universities is 681. From a macro point of view, the volume of awarded patents is on the rise, and the number of awarded patents has been stable at about 80 pieces/year in the past five years. Although the number of invention patent of the Gold Award and invention patent of the Silver Award is clearly limited under the Measures for Awarding China Patent Awards, the number of awarded universities in China is still on the rise. Among the 150 awarded universities, 78 are top universities, accounting for 52%. There are 25 NIPDC in the top universities. Tsinghua University has 56 awards, which makes it the most awarded university. Among the 34 provincial administrative units, except Inner Mongolia Autonomous Region, Tibet Autonomous Region, Qinghai Province, Taiwan, and Macao, all the provincial administrative units of

awarded universities have won awards once, of which Beijing has the largest volume of awards, followed by Jiangsu Province, Guangdong Province, Zhejiang Province, and Shandong Province. Among the 681 patents, the number of valid patents and authorized patents accounts for 77% and 76% respectively, and the number of invalid patents accounts for 23%, among which 84% are not paid an annual fee. Among the 215 operating patents, 94.9% adopted a single patent operation model, and only 5.1% operated in multiple patent operation models. In the single operation model, the proportion of patent transfer is 54%, and the license of patent exploitation is 45%. Of the 215 operating patents, 102 were licensed, with the largest number of exclusive licenses, with general and solo licenses accounting for approximately 50%. We found that Part C (chemistry and metallurgy) is the most popular field awarded by universities.

The research on the analysis of the winners of the China Patent Awards from 13th to 21st shows that [2], the enterprise is the main winner of patents, accounting for approximately 75%, while the universities and scientific research institutions account for approximately 20%. The number of patent applications and authorized patents in colleges and universities has increased significantly every year. By the end of 2018, the top universities have over 273,000 valid patents twice as much as in 2016 [3]. Wang Xianghong et al. [4] found in their research on the analysis of the patents awarded in the previous the China Patent Awards from the 1st to the 20th that the number of patents awarded in Guangdong Province, Beijing, Jiangsu Province, Shandong Province, and Zhejiang Province ranked among the top five, in which Guangdong Province has the largest number of awarded patents, followed by Beijing, which is much higher than other provinces. As a result, the provinces with the largest volume of university awards are consistent with this study. The regional economy is a major driving force for promoting scientific and technological innovation. Further, regional innovation policies are conducive to improving regional innovation ability. Guangdong Province, the largest economy province in China, has high intellectual property workability. Beijing, as a political center, cultural center, international communication center, and scientific and technological innovation center, has a large scale of universities and scientific research institutions, therefore it naturally has significant innovation advantages [4, 5]. However, Jiangsu, Shandong, Zhejiang, and other places belong to coastal developed areas, with high economic strength and innovation levels. The cultivation of high-value patents requires accurate positioning of innovation subjects and service institutions, and optimization of the allocation of policy resources, technical resources, human resources, and financial resources [6]. Obviously, the institution of patent information service of the university library should improve the innovation strategy of patent information service [3].

Universities are one of the main forces of scientific and technological innovation in China, and play a leading role in basic research and high-tech [7, 8]. The China Patent Awards has experienced over 30 years of development. Undoubtedly, it plays a notable role in demonstrating and guiding the enhancement of China's scientific and technological innovation capability and improving the quality of the intellectual property. The recognition and attention of all sectors of society have also increased year by year. It is not only an endorsement of the winners' ability in scientific and technological innovation but also stimulates the innovation enthusiasm of the whole society. Universities have incorporated the China Patent Awards into one indicator of social service, setting a new navigation mark for independent innovation of universities.

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