



# Research on the Contribution of Colleges and Universities to Industrial Scientific and Technological Innovation Based on Patent Data Analysis

Lusheng Wu<sup>1</sup> and Xiaoqing Zhang<sup>2</sup>(✉)

<sup>1</sup> Office of Scientific R&D, Jinan University, No. 601, Huangpu Avenue West, Tianhe District, Guangzhou, Guangdong, China

twls@jnu.edu.cn

<sup>2</sup> The Graduate School, South China Agricultural University, No. 483, Wushan Road, Wushan Street, Tianhe District, Guangzhou, Guangdong, China

zhangxq@scau.edu.cn

**Abstract.** Patent is one of the important ways to disclose scientific and technological innovation achievements. Compared with other types of scientific research achievements such as papers, patent achievements have more industrial value, and patent-related index information can better reflect the innovation ability and level of innovation subjects. Through the analysis of patent data index of Guangdong universities, this study deeply explores the contribution of Guangdong universities to the biological industry, which will help the government guide universities to carry out organized scientific research activities through policies, expand and strengthen the advantages and characteristic disciplines of the characteristic biological industry, and drive the biological industry in the “Pearl River Delta” region to enter a period of high-quality development. The author analyzed the contribution of colleges and universities in Guangdong to the biological industry by using the method of multi-index weighted scoring ratio, and quantitatively studied the technological advantages and industrial contributions of 10 colleges and universities in the fields of bio-agriculture, bio-medicine, bio-industry and bio-environmental protection. Ten universities in Guangdong have the highest contribution rate to Guangdong bio-industry, which is 24.81% in recent ten years. The contribution rate of the ten universities to Guangdong bio-environmental protection industry decreased year by year, and dropped to 4.14% in 2020. Ten universities in Guangdong have the largest number of patent applications in bio-industry, but the proportion of authorized patents in bio-industry in Guangdong province is the lowest. South China Agricultural University has the highest contribution rate to bio-agriculture and bio-industry in Guangdong province, which are 7.57% and 7.31% respectively in recent ten years. In terms of patent operation status, the highest proportion of patent transfer in the field of bio-industry and licensing in bio-agriculture is 8.34% and 22.58% in ten universities in Guangdong. Strengthening the top-level design of bio-industry-related disciplines layout in Guangdong

colleges and universities, improving the quality of patent achievements in Guangdong colleges and universities, and improving the efficiency of patent achievements transformation in Guangdong colleges and universities will provide powerful engine and intelligent support for the development of Guangdong bio-industry in colleges and universities.

**Keywords:** Bio-Industry · Patent Information · Weighted Score · Contribution

## 1 Introduction

With the rapid development of modern biotechnology such as genetic engineering, bioreactor engineering and quantitative genetic engineering, modern biotechnology will exert more profound influence on the production and life of human society [4]. Biotechnology will become the main driving force for the development of international science and technology, and the biotechnology industry will also become another “tuyere” industry in the world economy after the information technology industry. The new economic pattern of the world is being rebuilt, which will directly affect the comprehensive competitive strength of the world’s major economies. With the rapid development of the global biological industry [1, 20], governments of all countries have increased the investment in research and development funds related to the biological industry. For example, 49% of the basic research funds in the United States are used for biotechnology and life science research [2, 15]; The siphon effect of the biological industry on capital is obvious, and the amount of venture investment, listing financing, M & A and restructuring transaction has repeatedly hit a record high. Research and development activities related to China’s biological industry are very active [31]. In 2018, a total of 9 independently developed class 1 new drugs were approved for listing in China, and the market size of the biomedical industry has exceeded 350 billion yuan; The scale of the biopharmaceutical industry in Guangdong Province is developing steadily, and the cluster effect of industrial development is prominent [31]. At present, there are industrial clusters such as Guangzhou International Biological Island, Shenzhen Pingshan National Bioindustry Base, Zhuhai Jinwan Biomedical Industrial Park, and a number of national gene banks. Major scientific and technological infrastructure, and the development level of biomedicine and health industries are at the forefront of the country.

In 2015, Guangdong Province successively started the construction of 10 high-level universities such as Sun Yat sen University, Jinan University, Shenzhen University and Southern University of science and technology, which further enhanced the independent innovation ability of Guangdong province, and also further improved the competitiveness and international influence of the whole Pearl River Delta region. The influence of colleges and universities on the economic and social development is omnidirectional, such as cultivating high-quality talents with innovative ability for the society, solving common key technical problems for enterprises and industries, enhancing the core competitiveness of enterprises and industries, etc. The impact of colleges and universities on the economy and society includes talent training, scientific research, social services and cultural inheritance, but there are few quantitative studies on the contribution of colleges

and universities to the industry. This study intends to explore the quantitative analysis method of Guangdong universities' contribution to the strategic emerging industry bio-industry through the relevant index information of Guangdong universities' patents.

Colleges and universities are one of the important subjects of knowledge output and an important source of original innovation in various countries and regions [30]. Because of their advantages in talent accumulation, scientific research conditions, international exchanges and literature acquisition, colleges and universities have become the main innovation subjects of original innovation [16]. Domestic and foreign scholars study the contribution of universities and other innovation subjects to the economy and society, mainly by studying the scientific and technological innovation ability of colleges and universities and other innovation subjects, such as constructing the innovation evaluation index system through innovation input, output, resources and environment, and using factor analysis to quantitatively and empirically study the scientific and technological innovation ability of colleges and universities [10]. The evaluation index system of scientific and technological innovation ability of colleges and universities is constructed from four dimensions of scientific and technological innovation basic ability, input ability, output ability and achievement transformation ability, and the entropy method is used to compare and analyze the scientific and technological innovation ability of colleges and universities in different regions [21]; however, due to the complex system of these first-level indicators extending the second and third-level indicators, it is difficult to obtain data, and most of the innovation entities have counted the overall basic research strength, investment ability, achievement transformation ability, etc. [8, 9, 14, 26, 32], it is difficult to obtain the index data of scientific and technological innovation ability in one field, especially when studying the contribution of universities to a certain field, it is difficult to give quantitative evaluation through the traditional scientific and technological innovation evaluation index system.

The domestic research on the analysis of industrial contribution began with the research on the contribution of industries to economic growth. Li Xingxu et al. started from the four characteristics of pillar industries and examined the contribution of the tourism industry to the driving effect of Yunnan's economy [27]. Afterwards, scholars carried out many research reports on the role of the information industry in promoting economic growth. Xu Shenghua et al., through the contribution model and empirical analysis of the information industry to economic growth, expounded that developed and developing countries regard the information industry as a new economic growth point, will play an important role in promoting the sustainable development of the national economy [19]; Chen Xiaolei et al. based on the C-D model and the Fide model, respectively, studied the contribution measurement model of the subdivision elements of the information industry to economic growth [24, 25]. Sun Honglei et al. used structural equation model to study the contribution of information industry elements to local economic growth, and proposed to build a coordinated development system for the information industry [6]. In addition, some scholars have also studied the contribution of the tertiary industry, agriculture, forestry, animal husbandry and fishery industry, cultural innovation industry, energy industry, pension service industry, and circulation industry to economic development [3, 7, 12, 13, 23, 33], but there is no literature report on the quantitative study of the contribution of innovation subjects to industry.

Patents are one of the important ways to disclose scientific and technological innovation achievements in applied basic research and technology development research. Compared with other types of scientific and technological achievements such as scientific papers and scientific reports, patent-related index information can more accurately reflect the invention of the innovation subject. With creative ability and level, more inspiring and closer to commercial application [17]. It can be seen that the analysis and mining of the patent-related data of the innovative subject can more accurately evaluate the innovative ability and level of the innovative subject in a certain technical field [16]. In recent years, the research on the competitiveness of innovation subjects based on patent related indicators has gradually deepened, such as analyzing the regional distribution characteristics of China's new energy vehicle technology innovation based on patent data analysis [28], identifying 5g mobile communication industry core technology based on patent data [22], analyzing China US artificial intelligence innovation ability from patent data [5], and analyzing the scientific and technological innovation ability of colleges and universities from the perspective of patents, etc. [16]. In addition, some scholars have established a patent index system to evaluate the level of regional patent output [11, 18, 29]. However, the research on the contribution of innovative entities in strategic emerging industries based on the quantitative analysis of patent data information of innovative entities has not been reported in the literature. Based on the patent-related data of ten universities in Guangdong province in the past 10 years, the author analyzed quantitatively the contribution of Guangdong universities to the biological industry and various fields of the biological industry for the first time by using the multi-index weighted comprehensive scoring ratio method. The contribution of innovation subjects to industry is quantitatively studied from the index of patent disclosure of the most important achievements of applied basic research and technology development research. Data processing and research methods.

## 2 Data Processing and Research Methods

### 2.1 Data Source and Processing

This paper takes the Chinese invention patents of biological industry of 2 high-level universities (Sun Yat sen University and South China University of Technology) and 8 universities (simply called "ten universities") in Guangdong (Jinan University, South China Agricultural University, South China Normal University, Southern Medical University, Guangzhou University of traditional Chinese medicine, Shenzhen University and Southern University of science and Technology), Through the established bio-industry and international patent classification comparison table [16], the number of patent applications, the number of patents granted and other relevant data indicators are directly linked with the bio-industry. The patent search platform of Innojoy is used to obtain the authorized patent data of Guangdong biological industry from January 1, 2011 to December 31, 2020 by compiling patent search formula Biological industry patent data of ten high-level universities in Guangdong Province. Taking Sun Yat sen University as an example, the retrieval formula of biological agriculture: ad = 20110101 to 20201231 and PA = "Sun Yat-sen University" and PIC = ("A01H" or "A01N" or "A01P"); Biomedical retrieval formula: ad = 20110101 to 20201231 and PA = "Sun Yat-sen University" and PIC =

(“A61B” or “A61C” or “A61D” or “A61F” or “A61G” or “A61H” or “A61K” or “A61J” or “A61L” or “A61M” or “A61N” or “A61P” or “A61Q” or “C07G” or “C07J” or “C07K” or “C08B” or “C08H” or “C08L” or “C12Q” or “C12R” Or “C12S” or “%G01N33%”), bio environmental protection search formula: ad = 20110101 to 20201231 and PA = “Sun Yat-sen University” and PIC = (“B09B3 / 00” or “C02F”); Bio Industry search formula: ad = 20110101 to 20201231 and PA = Sun Yat sen University and PIC = (“C10G3 / 00” or “C10L1 / 02” or “C10L1 / 08” or “C10L1 / 19” or “C10G3 / 00” or “C10L1 / 02” or “C10L1 / 08” or “C10L1 / 19” or “C11C3 / 04” or “C11C3 / 10” or “C12C” or “C12F” or “C12G” or “C12H” or “C12J” or “C12M” or “C12N” or “C12P” or “C13K”). The contribution of innovation subjects in the field of biological industry was quantitatively evaluated based on the data of invention patent applications, utility model applications and authorized invention patents of Guangdong universities by using multi-index comprehensive evaluation method.

## 2.2 Research Methods

The comprehensive weighted scoring method of multi-index test is to determine the weight of each index according to the importance of the test index in the test, and the obtained weighted scoring results are used as a single index to analyze the test results [7, 23]. The author uses the multi-index weighted scoring method to comprehensively evaluate the indicators of invention patent applications, utility model patent applications and invention patent authorizations in the four fields of bio-agriculture, bio-medicine, bio-industry, and bio-environmental protection in ten high-level construction universities in Guangdong. The evaluation scores can show the competitive advantages of Guangdong universities in different fields of the bio-industry. The contribution of Guangdong universities to Guangdong’s bio-industry is represented by the scoring ratio method. The calculation formula is as follows:

$$\rho_{ij} = \frac{V_{ijx} * 0.6 + V_{ijy} * 0.3 + V_{ijz} * 0.1}{V_{gix} * 0.6 + V_{g jy} * 0.3 + V_{g jz} * 0.1}$$

In the formula,  $\rho_{ij}$  represents the contribution of Guangdong  $i$  universities to the field  $j$  of Guangdong bio-industry,  $V_{ijx}$  represents the  $x$  index of invention authorizations in the field of bio-industry  $j$  of Guangdong  $i$  universities, and  $V_{ijy}$  represents the  $y$  index of invention applications in the field of bio-industry  $j$  of Guangdong  $i$  universities,  $V_{ijz}$  represents the  $z$  index of utility model applications in the field of bio-industry  $j$  in Guangdong  $i$  universities;  $V_{gix}$  represents the  $x$  index of invention authorization in the field of bio-industry  $j$  in Guangdong Province, and  $V_{g jy}$  represents the  $y$ -indicator of the number of invention applications in the field of bio-industry  $j$  in Guangdong Province, , and the coefficients 0.6, 0.3, and 0.1 are the weighted coefficients of the number of invention authorizations, the number of invention applications, and the number of utility model applications, respectively.

### 3 Empirical Study on “Ten Universities” Biological Industry in Guangdong

#### 3.1 Comprehensive Analysis of Biological Industry Patents

In the 21st century, technological breakthroughs centered on biological macromolecular design and gene splicing technology have promoted the technological revolution of the traditional biological industry. At the same time, the biological industry has also entered a “new era” of rapid development. The rapid development of the biological industry has had a great impact on the development of human economy and society, Countries all over the world have made medium and long-term development plans for the development of biological industry, which has become the focus of scientific and technological competition in the international community. Through the Dawei Innojoy patent search platform, we counted the number of invention patent applications, utility model applications, and invention patent authorizations of ten high-level universities in Guangdong Province (referred to as “ten schools”) in various fields of the biological industry from 2011 to 2020. We found that among the four fields of the bio-industry, the number of invention patent applications and utility model patent applications in the biomedical field were much higher than those of the other three fields; As can be seen from Table 1, the number of invention patent applications in Guangdong’s “Ten Schools” in the field of bio-industry in Guangdong Province is much higher than that of bio-agriculture, bio-medicine and bio-environmental protection, reaching 22.67% and 29.5%; The proportion of invention patent applications in the other three fields is less than 10%, and the lowest proportion of invention patent authorization in the field of biomedicine is only 1.59%; from the perspective of patent law status, the highest proportion of authorized patents for bio-environmental protection in Guangdong’s “ten schools” is 1.59%. 36.1%, and the lowest proportion of biopharmaceutical patents is

**Table 1.** Bio-industry patents and operating status of the “Ten Schools” in Guangdong Province in the past 10 years.

Biological industry		Number of applications and authorizations			Legal status			Operation status	
		apply	utility model	Invention authorization	Right	under advisement	no right	transfer	permit
Biological agriculture	TS	456	19	196	402	156	113	36	7
	PT	5129	366	1188	2496	1487	2700	541	31
Biomedicine	TS	9131	3009	3239	8354	4418	2607	523	15
	PT	91706	59274	202924	84917	43260	43727	13615	597
Biological environmental protection	TS	920	310	295	757	433	335	63	4
	PT	12556	19896	2402	2097	7631	6296	2387	111
Bioindustry	TS	2814	153	1243	2285	1181	744	142	11
	PT	12410	3684	4203	10508	5773	4016	1701	77

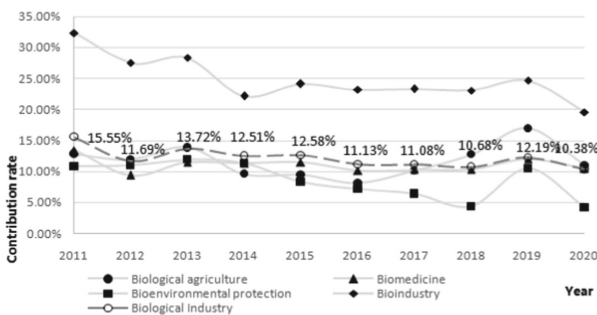
**Note:** TS = Ten Schools and Universities of Guangdong; PT = Total of Guangdong Province.

only 9.8%; from the perspective of patent operation, the highest proportion of patent transfer in the bio-industry field of Guangdong “Ten Schools” is 8.34%, and the highest proportion of bio-agricultural patents is 22.58%.

### 3.2 Contribution Analysis of Biological Industry

China’s economy has entered a “new normal”, and economic growth needs to be “speed-adjusted and quality-enhanced”, from the factor investment drive of extensive growth to the innovation drive of quality-intensive growth. The transformation and industrial upgrading of the national economy urgently needs the support of new scientific and technological innovation drives. As early as 2010, the executive meeting of the State Council identified the biological industry, new generation information technology, new energy and other industries as strategic emerging industries to cultivate. Colleges and universities are important carriers of high-end talent production in the national scientific and technological innovation system. Due to the increasingly obvious advantages of colleges and universities in talent gathering, scientific research and experiment platforms, international cooperation and exchanges, and literature data acquisition, colleges and universities have gradually become important in the original innovation of major economies. Guangdong universities have provided strong technical and intellectual support to Guangdong’s biological industry in terms of technological innovation and talent training, and incubated a number of listed Companies in high-tech fields with a market value of more than 10 billion, such as Daan Gene and Wen’s Group.

As can be seen from Fig. 1, among the four fields of biological industry from 2011 to 2020, the “Ten Universities” in Guangdong have the highest average contribution to biological industry, with contribution rates of more than 20%, of which the highest contribution rate in 2011 was 32.29%; It reflects that the researchers of Guangdong’s “ten universities” have shown strong interest in Bio Industry Research and technical protection. On the other hand, it also shows that the technological innovation capability of enterprises with bio-industry as the core in Guangdong Province needs to be improved; The contribution of Guangdong’s “Ten Universities” to Guangdong’s biological industry is more than 10%, of which the highest contribution rate in 2011 is 15.55%, and the years with a contribution rate less than 11% are 2018 and 2020; Due to the long cycle of



**Fig. 1.** Analysis of the contribution rate of Guangdong’s “Ten Universities” to the biological industry.

authorized invention patents and the impact of COVID-19, the contribution of various industries in the bioindustry increased rapidly in 2019, and dropped rapidly in 2020. The 12th Five Year Plan for the development of strategic emerging industries in Guangdong lists the biological industry as one of the eight strategic emerging industries, and takes the six directions of innovative drugs, modern traditional Chinese medicine, new vaccines and biomedical engineering as the key areas of the development of the biological industry. The biomedical enterprises in Guangdong Province are large-scale. For example, Guangyao group and Lizhu group are listed enterprises with annual sales of nearly 10 billion. The enterprise has strong R & D ability and great support for Guangdong biomedical technology, which weakens the contribution of Guangdong universities to Guangdong biomedical technology.

### 3.3 Contribution Analysis of Various Fields of Biological Industry

As can be seen from Fig. 2, the contribution rate of South China Agricultural University to bio-agriculture in Guangdong has been more than 5% in recent 10 years, more than 9% in 2013, 2018 and 2019, and more than 11% in 2019. The contribution rate of South China Agricultural University to bio-agriculture accounts for more than 60% of the contribution of Guangdong’s “ten universities”. It fully embodies the agronomy discipline characteristics and technology research and development strength of South China Agricultural University. As of March 2021, South China Agricultural University has 5 national key disciplines, including agricultural insect and pest control, crop genetics and breeding, agricultural economic management, fruit tree science and Preventive Veterinary Science, of which 4 are related to biological agriculture; It has the State Key Laboratory for the protection and utilization of subtropical agricultural biological resources, the national plant space breeding Engineering Technology Research Center, the national pig seed industry engineering technology research center, the national local joint engineering laboratory for the prevention and control of zoonosis and preparations, the national local joint Engineering Research Center for livestock and poultry breeding, the National Veterinary microbial drug resistance risk assessment laboratory Eight national platforms, including the national local joint Engineering Research Center for precision processing and safety control technology of livestock and poultry products and the National International Joint Research Center for precision agricultural aerial pesticide technology, are scientific research platforms in biological agriculture related fields; It can be seen that the level of discipline construction and scientific research (platform)

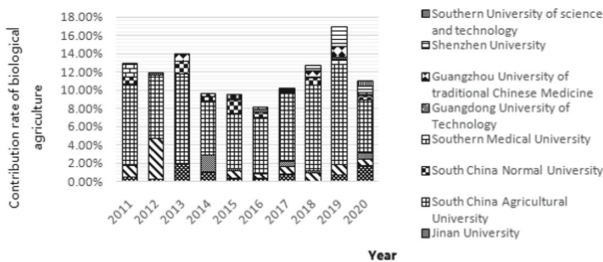


Fig. 2. Analysis of contribution rate of “Ten Universities” to biological agriculture in Guangdong.



strength of colleges and universities directly determine their ability and contribution to local economic services.

As can be seen from Fig. 3, the technical contribution of Guangdong universities to the biomedical industry has been maintained at a low level, and the contribution of Sun Yat sen University was close to 3% in 2013, 2014 and 2019; In 2011, the contribution of South China University of technology exceeded 4%, and the annual contribution of other universities to Guangdong biomedical industry did not exceed 2%; On the one hand, it shows that the volume of biomedical technology innovation in Guangdong universities is small, and on the other hand, it also shows that other types of innovation entities are in the field of biomedicine; After the reform and opening up, especially in the past 20 years, the economic strength of Guangdong Province has improved significantly. Guangdong Province has increased capital investment in the biological industry, formulated relevant policies, and vigorously supported the development of the biomedical industry. In the “13th five year plan” for scientific and technological development of Guangdong Province, biotechnology drugs and preparation technology, modernization of traditional Chinese medicine, biocatalysis and biotransformation technology, biomedical materials, etc. have been listed as the priority development topics to promote the rapid development of biomedical industry in past 10 years; Gradually formed a number of leading enterprises with an output value of more than 10 billion, such as Lizhu Pharmaceutical Group, Guanhao biology, Huada gene, Daan gene and so on; The biomedical patent contribution data of Guangdong Universities in Fig. 3 also reflects that biomedical enterprises in Guangdong Province are the main body of technological innovation, and their position is stable.

From Fig. 4, it can be seen that from 2011 to 2017, the contribution rate of South China University of Technology to the field of bio-environmental protection in Guangdong was significantly higher than that of the other 9 universities. However, since 2017, Guangdong University of technology has introduced domestic high-level R & D teams through the construction of high-level universities in Guangdong Province, which has significantly improved its contribution to the field of biological environmental protection in Guangdong; From the overall trend, the contribution rate of colleges and universities in Guangdong to the field of biological environmental protection shows a downward trend, and the total contribution rate for three consecutive years from 2018 to 2020 is only about 4%. From Fig. 5, it can be seen that from 2011 to 2019, the technical contribution rate of Guangdong universities to the field of bio-industry exceeded 20%, and the contribution rate of South China University of technology to bio industry showed

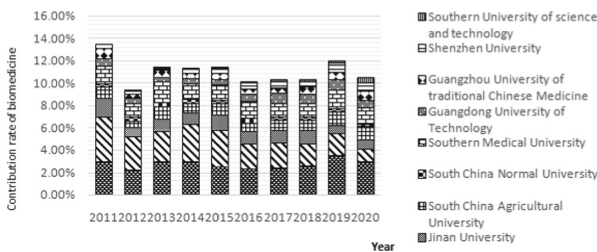


Fig. 3. Analysis of biomedical contribution rate of “Ten Universities” in Guangdong.

a downward trend. On the contrary, the contribution rate of South China Agricultural University to bio-industry showed an upward trend; in 2016, South China Agricultural University exceeded South China University of technology in the number of invention patent applications in the field of bio-industry. In the following four years, the number of invention patent applications in the field of bio-industry was close to or more than 100. In 2019, the number of invention patent applications in the field of bio-industry was 173 items, a record high. The bio-industry mainly includes relevant patents with classification numbers of C12F,F12G, C12H, C12J, C12M, C12N and C12P in the international patent classification table, mainly including “brewing of beer and fruit juice”, “microorganism or enzyme; reproduction, preservation or maintenance of microorganism; culture medium” and other technical processes. The bio-industry patents applied by South China Agricultural University are mainly concentrated in the technical field of C12N, the patents of the main inventor who applied for the most patents are mainly concentrated in C12N15 (mutation genetic engineering), C12N1 (microorganism itself, storage and preservation method), C12N9 (enzyme preparation, activation or inhibition, separation and purification method); In addition, South China Agricultural University has close technical cooperation with Guangdong Wenshi Food Group Co., Ltd., Dongguan agricultural science research center and Zhaoqing Dahua agricultural and biological drugs Co., Ltd. in the fields of pig embryos and Lactobacillus endosperm.

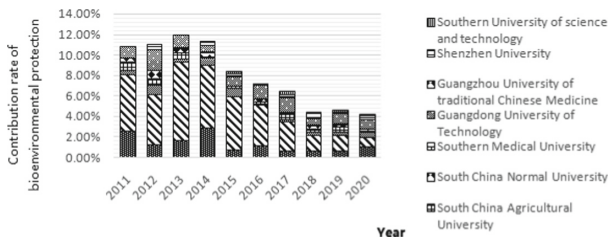


Fig. 4. Analysis on the contribution rate of biological environmental protection of “Ten Universities” in Guangdong.

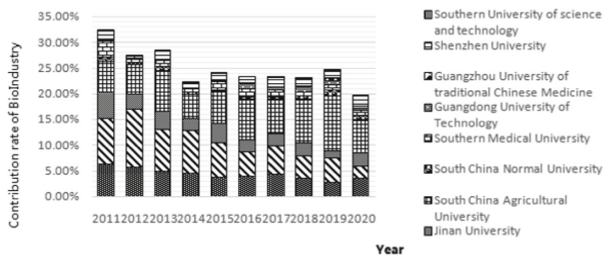


Fig. 5. Analysis of contribution rate of Bio-industry of “Ten Universities” in Guangdong.

## 4 Conclusions

Domestic bio-technology research and development and bio-industry development have experienced more than 30 years of development. Especially since the “Eleventh Five-Year Plan”, the State Council has issued several government documents such as “Several Policies for Promoting the Accelerated Development of bio-Industry” and “Eleventh Five-Year Plan for Bio-Industry Development” to support and promote the industrialization of innovative achievements in bio-technology research and development and life sciences from a policy perspective. The bio-industry is listed as one of the seven strategic emerging industries to be cultivated and developed by the state. The 13th Five-Year Plan for the development of strategic emerging industries in Guangdong Province clearly calls for accelerating the transformation and application of new technologies such as molecular breeding and bio-based materials. In the process of industrialization, efforts will be made to build the bio-industry into a pioneer in supply-side structural reforms and new drivers of economic development. As an important source of original innovation, colleges and universities occupy an important share in various scientific and technological outputs, and have made important contributions to the improvement of national and local scientific and technological innovation capabilities.

Based on the patent data of Guangdong’s “ten universities” in recent 10 years, including bio-agriculture, bio-medicine, bio-environmental protection and bio-industry, the author quantitatively analyzed the contribution of Guangdong’s ten universities to the bio-industry by using multi-index weighted comprehensive scoring ratio method. The results show that: from the perspective of patent operation status, the highest proportion of patent transfer in biological industry of Guangdong “ten schools” is 8.34%, and the highest proportion of patent licensing in biological agriculture is 22.58%. In Guangdong province, the number of invention patents applied and granted by the “ten schools” accounted for 22.67% and 29.5%, respectively, higher than that of bio-agriculture, bio-medicine and bio-environmental protection. However, the proportion of invention patent applications in the other three fields is less than 10%, and the proportion of invention patent granted in the biomedical field is only 1.59%; It can be seen that the contribution of Guangdong’s “ten schools” to the field of bio-industry in Guangdong Province is greater than that of bio-agriculture, bio-medicine and bio-environmental protection industries. Judging from the number of patent applications and authorized patents for biomedicine in the “Ten Schools” in Guangdong, they are far higher than the other three types of patents in the biological industry, but the patent ownership rate and the proportion of transfer and implementation licenses are at a low level. It can be seen that there is a large space for the improvement of the patent application quality and the later transformation work in the biomedical field in Guangdong universities. The contribution rate of South China Agricultural University to biological agriculture is above 5%, and the contribution rate in 2019 is more than 10%. This is closely related to the fact that the five national key disciplines and eight national scientific research platforms of the school are all distributed in the field of bio-agriculture, which effectively supports the strong support of South China Agricultural University for the development of Guangdong’s bio-agricultural industry. Since 2016, the contribution rate of South China Agricultural University to the bio-industry has maintained the first position among the “Ten Universities” in Guangdong, and the contribution of South China Agricultural University

to the bio-industry field of Guangdong Province has gradually emerged. The “Twelfth Five-Year” Development Plan of South China Agricultural University and the Outline of the Medium and Long-term Development Plan (2011–2020) formulated by South China Agricultural University proposes to select the best development to meet the needs of economic development and industrial structure adjustment in the Pearl River Delta, and vigorously develop science and engineering disciplines. The strategic layout of agricultural engineering, biological engineering, food science and engineering, environmental science and engineering, water conservancy engineering, energy and materials engineering, mechanical engineering, information science and technology and other science and engineering disciplines is based on merit. From the perspective of the contribution of industry, the effect of the school’s medium and long-term discipline layout is obvious.

## References

1. Anazawa H. (2010). Bioindustry in Japan-Current status and challenges. *Journal of Biotechnology* (150),83.
2. Bai J, Lin X, Yin Z. (2020). Status quo of global bioindustry and its policy implications. *Chinese Journal of Biotechnology*, 6(8),1528–1535.
3. Bing J, Yi Y. (2012). The contribute Rate of Energy Industry Expansion to Economic Growth of Shanxi Province. *Statistics & Information Forum*, 27(09),87–90.
4. Changlin W, Qi H. (2017). Strive to promote the supply side structural reform of the biological industry. *China Biotechnology*, 37(07),5–8.
5. Hongguang N, fan HR. (2020). A Comparative Study on the Creativity of Artificial intelligence Between China and the US Based on Patent data. *China Science and Technology Forum* (05),154–162.
6. Honglei S, Jianming Z. (2016). Contribution of Information Industry Elements to Regional Economic Growth. *Information Science*, 34(07),91–95+107.
7. Hui H, Ding X. (2012). Analysis on the economic contribution of pension service industry value chain. *Social Science Journal* (06),155–158.
8. Jianguo H, Weican Y. (2019). Evaluation and Improvement Paths of Science and Technology Innovation Ability of Beijing-Tianjin-Hebei Universities. *Chinese University Science and Technology* (03),42–44.
9. Jing X. (2015). Evaluation and promotion strategy of scientific and technological innovation ability of colleges and universities. *Chinese University Science & Technology* (11),60–61.
10. Jinguo W, Jingqiang Z, Jiao W. (2017). The evaluation study on science and technology innovation ability of beijing municipal colleges and universities. *Science & Technology Progress and Policy*, 34(20),108–112.
11. Jinyan C, Yunpeng X, Yu S, Qing H, Weijun Q, Yang L. (2004). Patent evaluation index system (II) -- using the indexes in the patent evaluation index system for data analysis. *Intellectual property* (05),29–34.
12. Jirong Z, mengyan Z. (2011). Analysis on the contribution of the development of cultural and creative industries to employment growth -- a case study of Beijing. *Modern communication* (05),144–145.
13. leilei C, Ningsheng Y. (2010). Analysis on the contribution of agriculture, forestry, animal husbandry and fishery industry to China’s agriculture. *Hunan Agricultural Sciences* (07),146–148.
14. Liang S, Shanjie Z, Weijiong C. (2014). The Status and Developing Strategies of Technological Innovation Capability of Shanghai Universities from Patent Perspective. *R&D MANAGEMENT*, 26(03),115–121.

15. Lifang Q. (2011). The basic situation and experience of bio-industry development at home and abroad. *Innovation* (02),66–70+127.
16. Lusheng W, Wang Z. (2018). Analysis on the Competitiveness of Patent Technology of Biotechnology Industry in Colleges and Universities of Guangdong Province. *Science and Technology Management Research*, 38(05),188–194.
17. Miao W, Jie M, Xiaoqiang J, Mingxia L, Xiaohu W, Lei L. (2011). Construction and application of International Patent Classification and comparison table of biomedical industry. *Chinese Medical Biotechnology*, 6(05),392–394.
18. Qing H, Jinyan C, Weijun Q, Yang L, Yu S, Yunpeng X. (2004). Patent evaluation index system (I) -- Design and construction of patent evaluation index system. *Intellectual property* (05),25–28.
19. Shenghua X, Xiaobing M. (2004). Analysis on the contribution of information industry to economic growth. *Managing the world* (08),75–80.
20. Wang R, Cao Q, Zhao Q, Li Y. (2018). Bioindustry in China: An overview and perspective. *New biotechnology*, 40,46–51.
21. Wangang C, Jianguo Z. (2019). Comparative Research on the Evaluation of Science and Technology Innovation Ability of Universities. *SOCIAL SCIENTIST* (10),49–53+59.
22. Wu Y, Dafei Y. (2019). Research on Identification of Industrial Core Technology Based on Patent Data —Taking the Field of Fifth Generation Mobile Communication Industry as an Example. *JOURNAL OF INTELLIGENCE*, 38(03),39–45+52.
23. Xiaodong W, Lijuan X. (2010). On the Adjustment of Circulation Industry Structure and Employment Growth—Based on the Analysis of the Contribution of Circulation Industry in Central China to Employment Absorption. *Finance& Trade Economics* (02),98–103.
24. Xiaolei C, Jianming Z. (2009). Contribution of the Information Industry Sub-elements to Economic Growth with Feder Model. *Library and information work*, 53(14),36–39+14.
25. Xiaolei C, Jianming Z. (2009). Contribution of the Information Industry Sub-elements to Economic Growth Based on C-D Model. *Information Science*, 27(09),1305–1310.
26. Xin Z, Shao W. (2016). Research on evaluation of regional science and technology innovation capability in Guangxi based on grey relational analysis model. *Science & Technology Progress and Policy*, 33(22),109–115.
27. xingxu L, Yinan M. (2004). Analysis on the contribution of tourism industry to Yunnan's economic growth. *Urban issues* (03),43–45+49.
28. Xiu S, Rui J, Gang Z, Hou GM. (2018). Analysis of Regional Distribution Characteristics of New Energy Vehicle Technology Innovation in China Based on Patent Data. *Journal of industrial technological economics*, 37(08),60–67.
29. Yang L, Weijun Q, Qing H, Yunpeng X, Yu S, Jinyan C. (2004). Patent evaluation index system (III) -- regional evaluation using patent evaluation index system. *Intellectual property* (05),35–38.
30. Yansong X, Fuqiang L. (2011). Study on the function of university in national innovation system. *Science & Technology Progress and Policy* (20),144–150.
31. Yin Z, Bai J, Lin X. (2020). Assessment and empirical analysis of the competitiveness of bioindustry in various regions of China. *Sheng wu Gong Cheng xue bao= Chinese Journal of Biotechnology*, 36(10),2216–2225.
32. Yingbo H, Jian W, luojun L, Xingchun W, Yong T, Xiaoxuan L, Zhou HP, Hua Z, Xianzhong L. (2016). A research on the evaluation of scientific and technological innovation capacity for national defense research institutes. *Science Research Management*, 37(03),68–72.
33. Yuan D, Shugao Z. (2005). An analysis on the contribution of the tertiary industry to the growth of GDP. *Chinese circulation economy* (02),32–35.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

