

Research on the Transition and Upgrading of the Patent-Intensive Industry in China: A Case of the bio-Pharmaceutical Industry

Xia Zhou and Wentong Wang

Abstract—With the increasingly prominent role of patents in the national economy, China regards the cultivation of the patent-intensive industry as an important way to build a strong intellectual property country and implement an innovation-driven development strategy. The patent-intensive industry is a rapidly growing strategic emerging industry with strong economic driving ability and strong market competitive advantage. A patent-intensive industry refers to an industry that relies heavily on technical and intellectual factors in production processes that are more dependent on other factors of production. Among them, the bio-pharmaceutical industry has always been valued as a permanent sunrise industry by all countries in the world. As a high-tech, high-input, high-risk and high-yield patent-intensive industry, its dependence on intellectual property protection is much higher than other industries. In recent years, the bio-pharmaceutical industry in China has shown a rapid development trend, which has initially formed an industrial space pattern with the Yangtze River Delta and the Bohai Sea as the core, as well as the Pearl River Delta and the Northeast developing rapidly. However, the overall competitiveness is weak and urgently needs transition and upgrading. This paper combs the development status of the bio-pharmaceutical industry from 2010 to 2017 in China, and then analyzes current situations and characteristics of the bio-pharmaceutical industry based on the industry life cycle theory. Finally, the paper proposes countermeasures to promote the transition and upgrading of the bio-pharmaceutical industry in China.

Index Terms—China, the patent-intensive industry, the bio-pharmaceutical industry, transition and upgrading.

I. INTRODUCTION

Under the guidance and promotion of science and technology, the global economy has achieved a leap from "agricultural economy-industrial economy - knowledge economy". At present, the third industrial revolution combining information and energy technology is becoming more and more popular. In addition, the emergence of innovative technologies such as artificial intelligence and 3D printing is gradually unveiling the fourth industrial revolution, which also indicates that a new round of global technological

changes is coming. In this context, the competition of future national strength must be reflected in the competition of technological innovation capability. The new economic growth theory shows that technological innovation is the source of economic growth and employment opportunities. The trend of the contemporary economy also shows that patents are playing an increasingly important role as an emerging production factor, and patent-based technological knowledge innovation is becoming a widely recognized innovation in society [1]. In short, the essence of innovation drive is the drive of patents. The key to the sustainable development of the world economy in the future lies in the role of patents.

Within the process of reform and opening up, China has achieved rapid economic growth and is the creator and holder of the highest growth record among the world's major economies. The growth rate is much higher than the world average, but such growth mainly relies on the labor, resources and investment advantages released by the institutional dividend of reform and opening up. At present, China's economy has entered a new normal, a series of problems such as slowing growth and deep-seated contradictions within the economy have gradually emerged. It is difficult for the extensive economic growth mode relying only on high input, high consumption and high pollution to shoulder the important task of sustainable and leapfrog economic development. At a time when international competition is becoming increasingly fierce, transition and upgrading are urgent, and China is at a critical moment to find new economic growth points. With the continuous development of the economy, the contribution rate of knowledge and technology to economic growth has become higher and higher. Therefore, in line with the new normal of global economic growth, patent-oriented innovation will also become the dominant force in China's economic growth [2].

As a new format, the patent-intensive industry has a major impact on the national economy. In 2015, the added value of China's the patent-intensive industry rose to 12.4% of GDP. In 2016, the patent-intensive industry realized a profit before tax of 2.6 trillion yuan, an increase of 10.1% year-on-year, which became a significant support for industrial transition and upgrading. At the same time, the prosperity and development of the patent-intensive industry also represents the advent of a new era. It is produced in the context of specific economic history, reflecting to some extent the future direction of economic development and the evolution of industrial development. Especially at present, the economic development is in a special period. There are fierce changes in

Manuscript received May 25, 2019; revised July 12, 2019.

Foundation items: National Social Science Foundation of China- "Research on the Strategy of Patent-Intensive Industry Upgrade Driven by Innovation" (18BJY099); the Soft Science Research Project of Guangdong Intellectual Property Office- "Intellectual Property Strategy of Technology Service Industry in Guangdong Pearl River Delta" (GDIP2016-G05)

The authors are with the Department of Business Administration, South China University of Technology, Guangdong, CO 510641 China (e-mail: wwtmaggie@163.com, 8605340@qq.com).

the economic field, and the corresponding industrial fields are also accelerating the pace of renewal. In this context, it is of great theoretical and practical significance to take the patent-intensive industry as the research object.

II. DEFINITION OF THE PATENT-INTENSIVE INDUSTRY

In October 2016, the State Intellectual Property Office issued "Catalogue of the Patent-intensive Industry", which referred to common international identification methods, including the characteristics of China's industrial development, adopted the combining method of quantitative and qualitative, and defined information basic industry, software and information technology service industry, modern transportation equipment industry, intelligent manufacturing equipment industry, bio-pharmaceutical industry, new functional materials industry, high efficiency energy saving and environmental protection industry, resource recycling industry. The patent-intensive industry needs to meet the following conditions: First, the industrial invention patent density and the invention patent authorization scale are above the national average; second, the industrial growth is good, and the policy orientation of innovation development is highly compatible [3].

According to the idea of factor density, a patent-intensive industry refers to an industry with the patent strength (number of patents/practitioners) higher than the overall average. From the perspective of measurement standards, the patent-intensive industry has the attributes of technology-intensive industries, relying mainly on technological innovation and patent advantages to participate in market competition. From the scope of measurement, the patent-intensive industry, the trademark-intensive industry and the copyright-intensive industry constitute the intellectual property intensive industry. Like all other industries, the patent-intensive industry also requires a large investment in production factors such as personnel and capital, of which the difference is that they focus on areas such as technology research and development and results transformation.

The level of intellectual property creation and utilization represented by patents is an important characterization of an innovative country and also a concentrated expression of the ability of independent innovation in industry. In the global economic arena, the patent-intensive industry plays a pivotal role, with the "three highs" characteristics of high-tech content, high growth, and high output value, which is the core support for implementing the innovation-driven development strategy, an important way to achieve industrial transition and upgrading and the key force to promote sustained economic growth.

III. SELECTION OF STUDY SAMPLES

Given that the patent-intensive industry consists of eight major industries, the development of each industry is quite different. In order to study the development and changes of an industry and the current challenges thoroughly, with the aim of propose corresponding strategies for transition and upgrading, this paper selects the bio-pharmaceutical industry

as a research sample according to the following principles.

- 1) It is a typical patent-intensive industry with a patent intensiveness of more than 100 pieces per 10,000 people.
- 2) It has a certain growth potential and is one of the few industries that are less affected by economic slowdown [4].
- 3) As a permanent sunrise industry, it has been valued by countries all over the world, especially developed countries. Many countries regard the bio-pharmaceutical industry as a strategic industry with priority development in the 21st century [5].
- 4) As an emerging industry, it has a good development prospect and a vigorous vitality, which has caused China to pay enough attention. In recent years, the central and local governments have been increasing their investment in biomedicine and supporting the bio-pharmaceutical industry in terms of policies and funding.

IV. ANALYSIS OF THE DEVELOPMENT STATUS OF BIOMEDICAL INDUSTRY

As is shown in Fig. 1, as of the end of 2017, the number of biomedical enterprises in China has reached 7,697, an increase of 248 over the same period of the previous year. Throughout 2011-2017, the number of biomedical enterprises in China has continuously increased, with a total increase of 2,023 in seven years, which is very rapid.

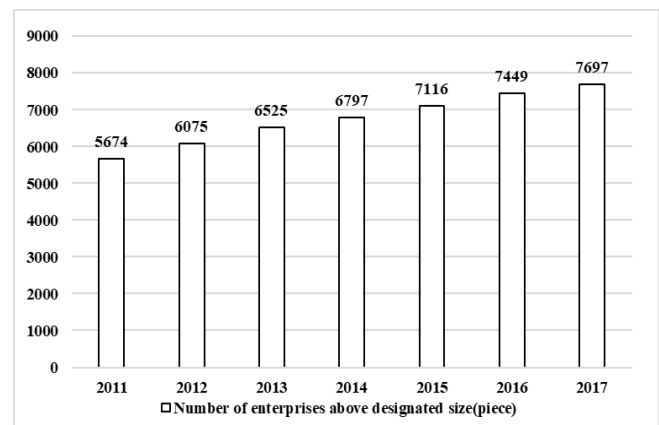


Fig. 1. Number of enterprises above designated size in China's bio-pharmaceutical industry in 2011-2017.

(Sources from National public information)

Since 2001, the gross industrial output value of China's pharmaceutical industry' has maintained rapid growth, and China has become the world's largest emerging pharmaceutical market. According to statistics, the compound output value of China's biomedical industry reached 23.32% during the "Eleventh Five-Year Plan" period. Since entering the "Twelfth Five-Year Plan", the gross industrial output value of the pharmaceutical industry has maintained a relatively fast growth trend, but the growth rate has slowed down due to the joint influence of multiple factors such as economic restructuring. As is shown in Fig. 2, from 2010 to 2017, the gross industrial output value of the bio-pharmaceutical industry increased from 1,235 billion yuan to 3,641.2 billion yuan, with an average annual compound growth rate of 16.70%.

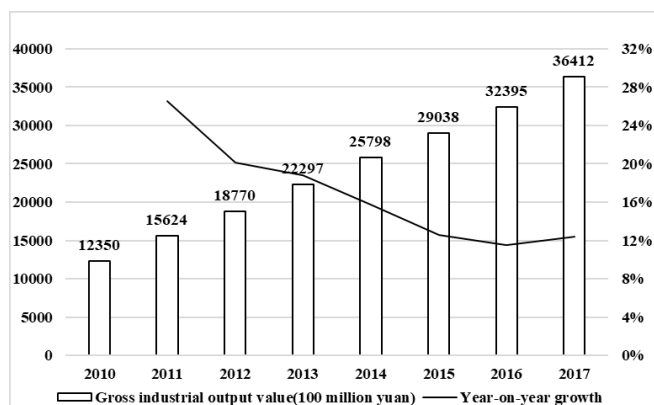


Fig. 2. Total industrial output value and growth rate of China's bio-pharmaceutical industry in 2010-2017.
(Sources from National public information)

Although the growth of the gross industrial output value of the pharmaceutical industry slowed down last two years, the focus of government investment has shifted from large and medium-sized hospitals to community hospitals and rural hospitals, when the reform of the medical system advances continuously, and the construction of social security system and framework for health care system basically completed. Meanwhile, the proportion of national health expenditure has continued to rise. Dividends of reform and opening up provides new growth space for the pharmaceutical market. Furthermore, considering the sustained growth of China's economy, the improvement of per capita income, the accelerated speed of population aging, the improvement of urbanization level, the change of disease map, the improvement of industry innovation ability and the improvement of medical insurance system, it is expected that the pharmaceutical industry in China will continue to grow rapidly.

At the same time, the profitability of China's bio-pharmaceutical industry has been in a stable trend for a long time. As is shown in Fig. 3, in 2017, the gross profit rate of China's bio-pharmaceutical industry reached 32.4%, an increase of 3% compared with the previous year.

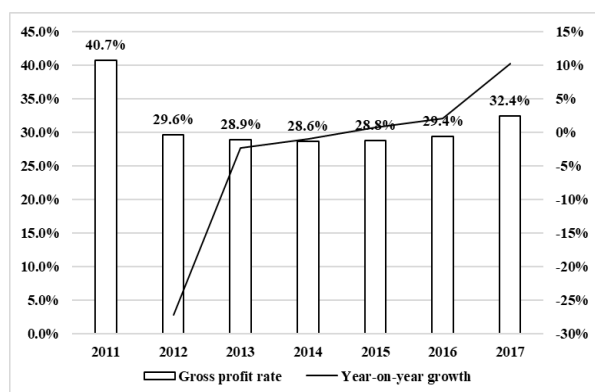


Fig. 3. Gross profit rate and growth rate of China's bio-pharmaceutical industry in 2011-2017.
(Sources from National public information)

Since the "Twelfth Five-Year Plan", due to the development of economic development and the reform of medical system urging continuous release of demand, the revenue and gross profit of enterprises above designated size in China's pharmaceutical industry have increased year by

year, more than doubled from the end of the "Eleventh Five-Year Plan". In 2013, the revenue of enterprises above designated size reached 2 trillion, but the growth rate has slowed down in recent years. In 2015, the revenue of enterprises above designated size reached 25,537.1 billion yuan, an increase of 9.48% year-on-year, and the growth rate was lower than 10% for the first time in the last decade. In 2017, it was 29,826 billion yuan, an increase of 6.28% year-on-year. On the other hand, although the growth rate of revenue continued to slow down, that of profit before tax remained stable. In 2017, the biomedical industry realized a profit before tax of 351.97 billion yuan, an increase of 17.21% year-on-year with the trend of rising steadily.

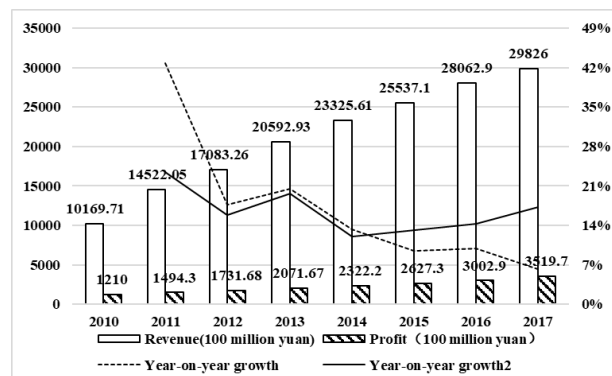


Fig. 4. Revenue, profit before tax and growth rate of main business of bio-pharmaceutical enterprises above designated size in China in 2010-2017.
(Sources from National public information)

The bio-pharmaceutical industry mainly includes eight sub-sectors: chemical raw material manufacturing, chemical preparation manufacturing, Chinese medicine decoction processing, proprietary Chinese medicine production, bio-pharmaceutical manufacturing, sanitary materials and medical supplies manufacturing, pharmaceutical-specific equipment manufacturing, medical equipment and equipment manufacturing. The growth of the revenue of the eight sub-sectors in 2017 is shown in Fig. 5. The fastest growth is the Chinese medicine decoction processing industry and the chemical raw material manufacturing industry, with growth rates of 16.7% and 14.7%. The slowest growth rate was the manufacture of pharmaceutical-specific equipment with a growth rate of 7.7%.

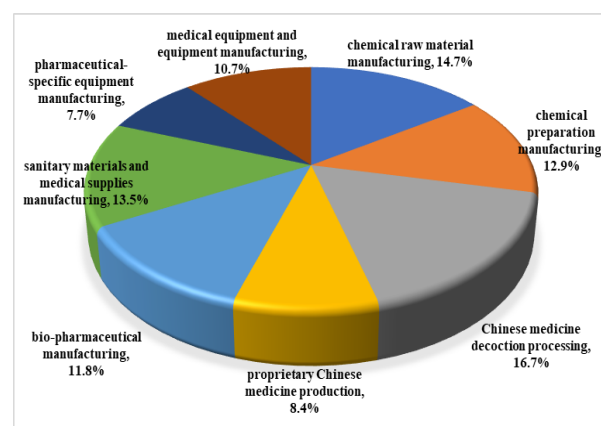


Fig. 5. Revenue growth in subsectors of China's bio-pharmaceutical industry in 2017.
(Sources from National public information).

The growth rate of profit before tax is higher than the growth rate of main business income, and the overall profitability of the industry has been improved. The growth of profit before tax of the eight sub-sectors is shown in Fig. 6. The fastest growth is in the bio-pharmaceutical manufacturing industry and the chemical pharmaceutical manufacturing industry, with growth rates of 26.8% and 13.7% respectively. The industrial development momentum continues to shift to high value-added products. The slowest growth is in the manufacture of pharmaceutical-specific equipment, with profit before tax falling by 8.1%.

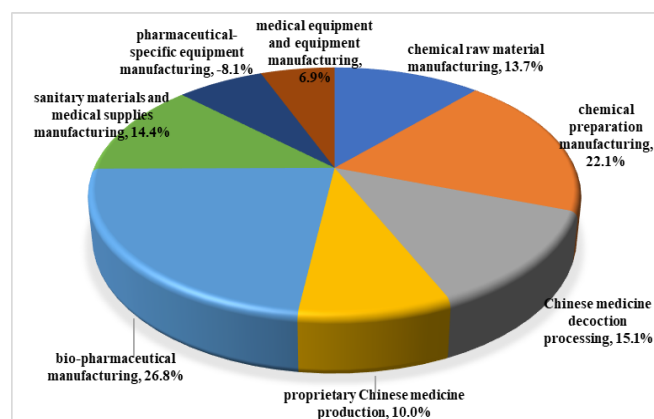


Fig. 6. Growth of profit before tax in subsectors of China's bio-pharmaceutical industry in 2017.
(Sources from National public information)

V. CHARACTERISTICS OF THE BIO-PHARMACEUTICAL INDUSTRY

A. Advantage

1) Huge market size

China is the world's largest emerging market. China's economy has experienced rapid growth for decades. Driven by factors such as population aging, urbanization, wealth growth and basic medical security system, Chinese residents are paying more and more attention to health issues. The demand for services has increased significantly, and the Chinese pharmaceutical market has expanded rapidly in recent years. In 2017, China's total health expenditure was 5,159.88 billion-yuan, accounting for 6.2% of GDP, but it was lower significantly than that of developed countries. Considering the huge base of population and consumption, it is not difficult to see that China's medical service market still have a lot of room for growth in the future. If this proportion reaches the target of 7% set by the Health Planning Commission in the "Healthy China 2020" Strategic Research Report in 2020, China's health consumption market will reach 7 trillion yuan. According to QuintilesIMS, China will become the world's second largest pharmaceutical market after the United States by 2020, accounting for 7.5% of the global pharmaceutical market.

2) Cluster development

In recent years, China's bio-pharmaceutical industry has shown a trend of agglomerative development, initially forming an industrial space pattern with the Yangtze River Delta and Bohai Rim as the core, as well as the Pearl River

Delta and Northeast China developing rapidly. In addition, Henan, Hunan, Hubei in the central region, Sichuan and Chongqing in the western region also have a good industrial base.

The innovation ability and international exchange level of the bio-pharmaceutical industry in the Yangtze River Delta region are relatively high. This region has the largest number of transnational bio-pharmaceutical enterprises, which have great advantages in R&D and industrialization, outsourcing services, international exchanges and other aspects, and has formed a bio-pharmaceutical industry cluster centered on Shanghai gradually [6].

The bio-pharmaceutical industry around Bohai Sea has abundant human resources and abundant clinical and educational resources. Provinces and municipalities have strong complementarity in the pharmaceutical industry chain, forming a strong innovation ability industrial cluster around Beijing.

The market economy system in the Pearl River Delta region is mature and has great market potential. The region has a well-developed medical circulation system, adjacent to Hong Kong and Macao, strong external radiation capacity, and relatively active private capital. Around Guangzhou, Shenzhen, Zhuhai and other key cities, a bio-pharmaceutical industry cluster with developed commercial network has been formed.

3) The government attaches great importance

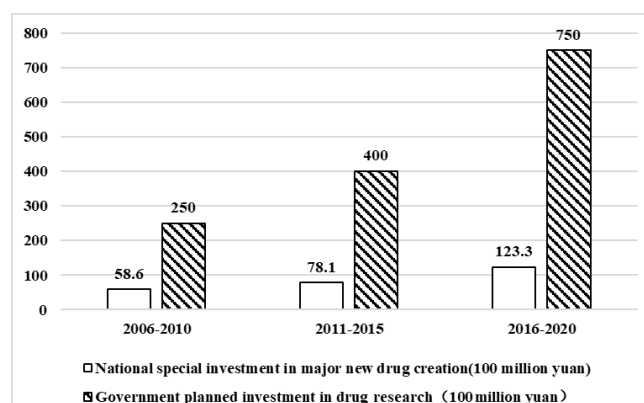


Fig. 7. National special investment and drug research in major new drug creation and government planned investment in drug research.
(Sources from National Science and Technology)

The Chinese government has always attached great importance to the development of bio-pharmaceutical industry and adopted various policies and measures to promote the process of industrial development vigorously. In order to promote the innovative development of bio-pharmaceutical industry, the state has issued a number of national plans related to bio-medicine, which further emphasizes the importance of biotechnology and pharmaceutical industry. Since 2016, the state has issued a number of policies to encourage drug innovation, including clinical trials, examination and approval, drug registration, patent protection and other aspects. Especially the "Opinions on Deepening the Reform of the Examination and Approval System and Encouraging the Innovation of Drug Medical Devices", issued in October 2017, is a policy issued by the General Office of the Central Committee of the Communist

Party of China and the General Office of the State Council to encourage drug innovation, which has raised pharmaceutical innovation to a new strategic level. The subsequent introduction and implementation of supporting policies are likely to exceed expectations.

At the same time, in order to support transition and upgrading of Chinese pharmaceutical companies, the government has provided financial support in the field of R&D. In recent years, the state's special investment in major new drug creation and the total government investment in drug research and development have increased significantly, as is shown in Fig. 7.

B. Disadvantages

1) Insufficient innovation in independent R&D

The market share of innovative drugs in developed countries like Europe, America, Japan has exceeded 60%, while the scale of Chinese pharmaceutical market is not as large as that in the United States. But it surpasses Japan and is close to Europe. However, the proportion of innovative drugs is less than 20%, which also includes a large number of imported innovative drugs. For example, cancer is the biggest direction of innovative drug research in the world. The R&D of anti-cancer drugs accounts for 40%-45% of the global R&D of new drugs. Although more than 220 clinical anti-cancer drug projects have been developed in China, and the types of targets are in line with the global hot directions, the discovery of new targets is still lagging behind the developed countries because of the late start of biological drugs in China and the main follow-up in the progress of research and development. At the same time, generic drugs are prevalent in China, which has a great impact on the pharmaceutical market. Generic drugs affect and control the R&D enthusiasm and capabilities of China's bio-pharmaceutical industry. Moreover, the overall scale of Chinese pharmaceutical companies is relatively small, the development is relatively scattered, the research strength is relatively weak, and the level of development is not high enough, so all of above have led to the lack of independent research and innovation motivation, and the competitiveness of enterprises has declined.

2) Insufficient talent in professional pharmaceutical industry

In the process of development of biomedicine in China, there is a serious shortage of professional and technical personnel, especially in the areas of bioengineering project operation, market development and capital operation. At present, personnel engaged in biomedical development and management are not highly educated, that is to say, the industry lacks technical personnel with high professional level, making it difficult to have large scientific research achievements and breakthroughs in the process of development, which is not conducive to the long-term sustainable development of the bio-pharmaceutical industry [7].

3) Low industry concentration

Although there are many enterprises in China's bio-pharmaceutical industry, they are not well-balanced, and

the main components are small and medium-sized enterprises, which account for more than half of the national pharmaceutical companies. Generally, these enterprises lack high-precision biomedical technology, while produce more common drugs, generic drugs. Moreover, they lack of technological innovation and the R&D of new drugs, and product homogeneity is serious. Therefore, the bio-pharmaceutical industry is mainly a "small scattered" situation, of which the pattern is scattered, and the industry concentration is low.

4) Lack of brand awareness

More than half of China's biomedical enterprises lack brand awareness. Although China has well-known brands such as "Tongrentang" in traditional Chinese medicine, there are few well-known brands of Western medicine. Even though some enterprises with a long history have had a good influence in the industry, with the development of the pharmaceutical industry, these old pharmaceutical enterprises have lagged behind, unable to stand at the forefront of industrial development, and the brand value is limited. It is worth noting that some enterprises of China do not have a strong awareness of brand protection, and do not attach importance to the maintenance of independent intellectual property rights. Many well-known brands have been squatted abroad, causing great losses to Chinese enterprises. Therefore, the number of well-known brands in Chinese pharmaceutical companies is small, and some pharmaceutical companies do not even have their own brands and they just do simple processing for other companies. Some Chinese enterprises do not attach importance to brand cultivation, which has a certain relationship with China's bio-pharmaceutical industry with low barriers to entry and low illegal costs. Some enterprises have speculative psychology, and only focus on short-term effects rather than brand cultivation, which brings a great crisis to China's pharmaceutical brands.

5) Poor ability of medical equipment and after-sales service

There is a technological gap between China's cutting-edge equipment and well-known foreign companies. Due to the limited number of sales, the after-sales service costs are high. Most of the mainstream markets are monopolized by multinational corporations. China's cutting-edge equipment market is fragmented, and it is over-reliant on price competition. The service cost is included insufficiently and it is difficult to provide perfect after-sales service. There are still a few enterprises in China which are speculative and do not plan to provide after-sales service. These factors lead to the failure of China's after-sales service of medical devices and the loss of customer confidence, which makes China's opportunities in the international medical market less and less.

VI. UPGRADE STRATEGY OF THE BIO-PHARMACEUTICAL INDUSTRY

The importance of industrial upgrading is unquestionable, but the connotation of industrial upgrading is still difficult to unify completely. Some scholars grasp it from a macro level. For example, Porter (1990) suggests that, in theory, industrial

upgrading means that when capital (manpower and material resources) is more abundant than labor and other resources, the state develops comparative advantages in capital and technology-intensive industries [8]. While some scholars focus on defining them at the meso or micro level, Gereffi (1999b) argues that industrial upgrading is the process by which a firm or economy can improve its ability to move toward more profitable capital and technology-intensive economies [9]. Poon (2004) argues that industrial upgrading is a process in which manufacturers can transfer their economic roles from producing labor-intensive low-value products to producing higher-value capital or technology-intensive products successfully [10]. However, no matter what level it is, the common point is that industrial upgrading is the process of industrial evolution from low-tech, low-value-added state to high-tech, high-value-added state.

Generally, the value chain of the bio-pharmaceutical industry mainly includes new drug discovery, drug development, drug manufacturing, drug sales and service brand operation. In the whole industrial value chain, there is difference in high value-added at both ends and low value-added in the middle. If we describe this difference phenomenon with a smooth line, we will find that this smooth line presents a perfect "smile curve" and the "smile curve" has a large amplitude at both ends. Based on the perspective of the value chain, this paper puts forward the upgrading strategy of the bio-pharmaceutical industry [11].

A. Strengthen Cooperation between Industry, Universities and Research Institutes in order to Form a Sound R&D System

Bio-pharmaceutical enterprises should take the initiative to strengthen exchanges and in-depth cooperation with universities at home and abroad. Based on drug screening and activity discovery, clinical trials, process design and quality standards, follow-up R&D and other links, enterprises should integrate enterprise resources, establish and improve the corresponding R&D centers. Meanwhile, the government should take the lead in establishing communication mechanism, implementing the "talent sharing plan" and supporting the flexible flow of R&D talents in scientific research institutes and universities. The government should also subsidize universities and research institutes to set up offices for the transformation of scientific and technological achievements, and set up special personnel to communicate and coordinate related matters. At the same time, the government needs to encourage the biotechnology talents of universities and scientific research institutes to feedback the latest scientific research results to enterprises through the Office of Achievement Transformation, so as to speed up the transformation of scientific research results into final products.

B. Give Full Play to the Role of the Association of the bio-Pharmaceutical Industry

It is significant to strengthen the role of trade associations in biomedical information exchange, innovation resource sharing, market investigation and prediction, intellectual property protection, policy research and so on. It is also important to strengthen information, resource exchange and cooperation with well-known international biomedical

enterprises and industrial clusters, introduce and absorb their new technologies so as to help cluster enterprises carry out independent R&D of bio-pharmaceuticals. All these measures can promote enterprises to carry out secondary innovation based on their own research and form subordinate patents or dependent patent.

C. Establish a Talent Support System

Firstly, the state needs to improve the quality of labor force in order to achieve the new growth of labor factor productivity, and strengthen the training of talents in biomedical enterprises. Then, as the guarantee of the sustainable development of biomedical enterprises, all biomedical enterprises should take actions from both domestic education and the introduction of foreign countries to cultivate high-level and compound talents to adapt to the development of biomedical enterprises, so as to improve the management efficiency of enterprises, activate the internal vitality of organizations and enhance the competitiveness of enterprises.

At present, higher education in China attaches great importance to knowledge and theoretical basis education and neglects practice and technical skill education, which leads to many problems like weak teacher resources and poor hardware and software. Therefore, colleges and universities should combine their own advantages, take the market as the guide, optimize curriculum settings, and innovate a unique talent training mode in order to cultivate high-level talents who can grasp the direction of technology development and the frontier technology of science and technology. Besides, enterprises should take the initiative to carry out various forms of training courses, promote vocational education and skills training, cooperate with universities to train talents, and strengthen the construction of talent team. In the aspect of the introduction of the foreign talents, the government should take incentive measures to guide and attract overseas students and scientists to return home for employment and create a suitable environment to retain talents, so as to obtain the right to use high-tech talents. China can promote the development of bio-pharmaceutical industry by building a support system for biomedical talents.

D. Realize Coordinated Upgrade of Industrial Clusters

In order to achieve the coordinated upgrading of industrial clusters, the government should support the merger and reorganization of pharmaceutical enterprises in order to cultivate leading enterprises. Leading enterprises can focus on the key technologies of bio-pharmaceutical production and process improvement because they have strong financial and technological strength, cluster's small and medium-sized enterprises can be responsible for the production of non-critical links, packaging or small products with low profitability. Reasonable division of labor and resource allocation in the cluster can realize the spillover of non-core technology, improve the production capacity and efficiency of the whole biomedical industry cluster, achieve win-win cooperation among cluster enterprises and solve the problem of low industry concentration. In addition, small and medium-sized enterprises in industrial clusters also need to strengthen the construction of software and hardware, improve technology absorption capacity, knowledge learning ability and management level in order to undertake the

knowledge spillover and production transfer of leading bio-pharmaceutical manufacturers.

E. Strengthen the Construction of Sales Network

On the one hand, bio-pharmaceutical enterprises should introduce and train high-level professional bio-pharmaceutical marketing talents and establish their own marketing team. At the same time, in areas with weak marketing foundation, enterprises can choose local investment partners with industry influence and higher professional quality by means of investment promotion, and continue to explore new business models. On the other hand, Bio-pharmaceutical Enterprises should try their best to form clusters and establish relationships with pharmaceutical commercial enterprises by hosting and participating in all kinds of high-level or high-impact bio-pharmaceutical exhibitions at home and abroad; meanwhile, they can provide professional sales service support for bio-pharmaceutical products, so as to make the clusters become long-term and dependent supplier bases for pharmaceutical commercial enterprises and medical institutions. In addition, these enterprises can accumulate social capital in the process of cluster and form a three-dimensional marketing network system.

F. Strengthen Brand Building

In terms of the building of brand, pharmaceutical enterprises can publicize their brands in high-level professional magazines in bio-pharmaceutical field. At the same time, enterprises can enhance their brand awareness and build their professional brand image by organizing or sponsoring academic exchanges, academic forums, supporting medical staff and bio-pharmaceutical researchers to conduct scientific research and consistency evaluation in related fields. In addition, biomedical enterprises should attach importance to patient education and provide patients with medication guidance, the knowledge of disease prevention and basic treatment through all kinds of medical institutions, rehabilitation institutions and other organizations to enhance the brand awareness and identity of enterprises [12].

ACKNOWLEDGMENT

The successful completion of the paper is supported by National Social Science Foundation of China- "Research on the Strategy of Patent-Intensive Industry Upgrade Driven by Innovation" (18BJY099) and the Soft Science Research Project of Guangdong Intellectual Property Office- "Intellectual Property Strategy of Technology Service Industry in Guangdong Pearl River Delta" (GDIP2016-G05). Thus, we are very grateful for the support and funding of the project. Last, we would like to express our gratitude to all the authors mentioned in the references that provide us advices

with during the writing of this paper.

REFERENCES

- [1] J. Ying, "Research on the economic growth driven by intellectual property intensive industries in Jiangsu province," *Master*, 2017.
- [2] J. E. Azzam, C. Ayerbe, and R. Dang, "Using patents to orchestrate ecosystem stability: the case of a French aerospace company," *International Journal of Technology Management*, vol. 75, pp. 97-120, 2017.
- [3] S. I. P. Office, *A Directory of Patent-Intensive Industries*, 2016.
- [4] What is the Patent Intensive Industry. (2017). [Online]. Available: https://www.sohu.com/a/129367312_466951
- [5] H. Shi, "The transformation & upgrading stage and characteristics of zhejiang bio pharmaceutical industry," *Technology Management Research*, pp. 141-147, 2017.
- [6] H. Hou and H. Pang, "Current situation analysis and countermeasures of pant intensive industry — A case of bio pharmaceutical industry in Guangdong province," *Science & Technology for Development*, vol. 13, pp. 555-566, 2017.
- [7] S. Collinson, H. Kato, and H. Yoshihara, "Technology strategy revealed: patterns and influences of patent-licensing behaviour in Japanese firms," *International Journal of Technology Management*, vol. 30, pp. 327-350, 2005.
- [8] X. Zhang and Y. Zhu, "Research on Industrial Upgrading from the Perspective of Global Value Chain," *Foreign Economics & Management*, vol. 27, pp. 21-27, 2005.
- [9] G. Gereffi, "International trade and industrial upgrading in the apparel commodity chain," *Journal of International Economics*, 1999.
- [10] T. Poon, "Beyond the global production networks: A case of further upgrading of Taiwan's information technology industry," *Int. J. of Technology and Globalisation*, vol. 1, pp. 130-144, 2004.
- [11] G. Liu, J. Ding, and B. Wu, "Research on China's high-tech industry cluster upgrading based on global value chain — A case study of biomedical industrial cluster," vol. 25, 2011.
- [12] J. Li, K. Jiang, and Y. Wang, "Analyzing the upgrading mode of bio-pharmaceutical industry cluster in view of industry value chain," *Administration of Health Services in China*, pp. 884-894, 2017.



Xia Zhou was born on January 1, 1964 in Jiangsu, China. She is a professor, who focuses on technological innovation and industrial upgrading at South China University of Technology, Guangdong, China.

She has been engaged in research on innovation management, industrial clusters and industrial upgrading for a long time. She has independently presided over many provincial-level scientific research projects. Her research results have won provincial and municipal social science achievement awards many times, and the innovation management policy recommendations have been valued by the leaders of relevant departments.



Wentong Wang was born on August 8, 1995 in Liaoning, China. She is a first-year student, who is learning the masters of business administration at South China University of Technology, Guangdong, China.

She is currently involved in research in the field of technological innovation and is adept at using Stata and EViews for empirical research in econometrics.