

Analysis and Calculation of Patent Self-Sufficiency Rate of Chinese Enterprises Based on Typical Cases

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Received 20 March 2022; Accepted 14 April 2022

Abstract. In 2021, the number of international patent applications in China will be the first in the world, but the self-sufficiency rate of Chinese patents is not high. According to data released by IC Insights, China's domestic chips are close to 6% self-sufficiency data. Therefore, according to the status quo of patent applications in China, this paper selects 4 typical enterprise patents from State Grid, Sinopec, Huawei, and OPPO according to the nature of the companies ranked among the top global applicants for PCT international patents. Relevant data is gathered and a classification analysis is conducted at beginning. Then the patent self-sufficiency rate of 4 typical enterprises is analyzed and calculated. The study found that the patent self-sufficiency rate of Chinese enterprises is not high at present. The stable development of the patent self-sufficiency rate is conducive to the sustainable development of enterprises. The patent self-sufficiency rate of Chinese enterprises increases with the increase of R&D investment.

Keywords: typical cases; Chinese enterprises; patents; patent applications; patent self-sufficiency rate

1. Introduction

In 2021, global innovative companies and individuals will overcome the disruption of the new crown epidemic, and the number of international patent applications submitted will reach a new high of 277,500[1]. In 2021, the country with the largest number of international patent applications submitted through the PCT is China, with a total of 69,540, a year-on-year increase of 0.9%. This was followed by the United States (59,570), Japan (50,260), South Korea (20,678) and Germany (17,322). Therefore, it can be seen that the number of applications in China is the highest in any country. According to statistics from the State Intellectual Property Office, in 2021, there will be more than 3.597 million valid invention patents in China [2-5]. In addition, 7 companies ranked among the top 50 in the total applicant ranking. However, according to the report "Several Policies to Promote the High-Quality Development of the Integrated Circuit Industry and Software Industry in the New Era", it shows that China's chip self-sufficiency rate in 2019 is only about 30%, mainly because China's patent self-sufficiency rate is not high. Therefore, studying the patent self-sufficiency rate of typical Chinese enterprises will help to understand the development status of China's patent transformation and further promote the healthy development of Chinese patents.

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2. Status quo of patent development of Chinese enterprises

2.1. Status of patent application in China

On February 10, 2022, data released by the World Intellectual Property Organization (WIPO) in Geneva shows that in 2021, China's PCT international patent applications will once again be ranked first in the world, and a total of 3 Chinese companies will enter the global PCT international patent applicant list. Besides Huawei Company, as a major patent holder, OPPO is also in the top ten of the global PCT international patent applicant list, and entered the list again with the sixth place. This is the third year that OPPO has ranked in the top ten of the global PCT international patent applicant list. It is also ranked second among Chinese enterprises for the third consecutive year. It can be seen that OPPO's scientific research strength is indeed progressing rapidly.

Table 1: Chinese Patent Leaders (2017-2021)

List of Leading Patent Enterprises in China (2017-2021)	
1	Huawei
2	OPPO
3	BOE
4	Midea Group
5	State Grid
6	Gree Electric
7	ZTE
8	Tencent
9	Ping An
10	VIVO
11	Chinese architecture

Data source: Wisdom Buds

The companies in Table 1 all appear in the list of the four dimensions of patent capability. Among them, Huawei, OPPO, BOE, and Midea Group entered the top 10 in the four sub-lists respectively; State Grid, Gree Electric, ZTE, Tencent, and Ping An entered the top 10 in three sub-lists; VIVO Entered the top 10 in the two sub-lists of PCT patent applications and patent citations[6-7].

From 2017 to 2021, in terms of total patent applications, State Grid, Huawei, Midea Group, Gree Electric, OPPO, China State Construction Engineering, BOE, Minmetals, China Southern Power Grid, and Tencent ranked in the top 10[8]. Among them, five companies, including State Grid, Huawei, Midea Group, Gree Electric, and OPPO, have filed more than 55,000 patent applications in the past five years, as shown in figure 1.

2.3. Development status of China's patent self-sufficiency rate

For a long time, China has been the world's largest chip importer and chip consumer. In the past 2018 and 2019, China's annual import of chips exceeded 300 billion US dollars [8]. At the same time, China also consumes nearly one-third of the world's chip products. China's State Council issued a new policy on the development of the domestic integrated circuit industry, which mentioned that China's chip self-sufficiency rate should be

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increased to 70% by 2025, while last year, my country's chip self-sufficiency rate was only about 30% [9-10]. Therefore, studying China's patent self-sufficiency rate will help to understand the current situation of China's patent development, so as to provide a reference for the future development of enterprise patents.

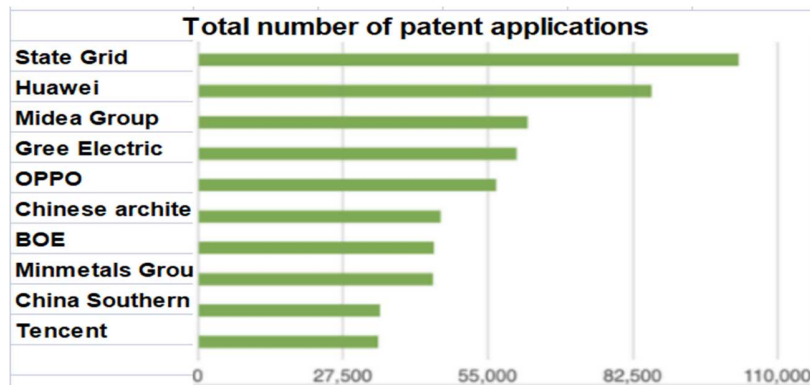


Figure 1: Top 10 companies with total patent applications in China in the past five years (Data source: Wisdom Buds).

3. Analysis of the status quo of patent development of typical Chinese enterprises

3.1. For state-owned enterprises

(1) State Grid

Among the Fortune Global 500 companies in 2021, State Grid Corporation ranks second among the Fortune Global 500 with a turnover of US\$386.618 billion, and ranks first among Chinese companies on the list. In terms of technology, State Grid Corporation is the first in China. In terms of the number of patented inventions in the past five years, the total number of patent applications of State Grid is 3,552 higher than that of Huawei.



Figure 2: The top 10 companies with patented inventions in China in the past five years

(2) Sinopec

Sinopec ranks first in the 2020 patent quality ranking of central SOEs published by the State-owned Assets Supervision and Administration Commission of the State Council of

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China. In the list of the 22nd China Patent Awards released by the State Intellectual Property Office, Sinopec has won 16 patents, including 1 patent gold award, 4 silver awards and 11 excellence awards. 22 petrochemical companies are listed in the 2021 global patent list, and Sinopec's number of patents ranks first in the industry. IFI Claims, an American commercial patent database provider, released the latest list of the top 250 global patents. The list is based on the cumulative patent holdings of enterprises, that is, the ranking of the list is related to the previous patent holdings, and is also affected by the number of new patents in the past year. Among them, there are 22 companies in the upstream petrochemical industry, and Sinopec and PetroChina are ranked fifth and eleventh in the world.

3.2. For private enterprises

(1) Huawei company

In 2021, the country with the largest number of international patent applications submitted through the PCT is China, with a total of 69,540, a year-on-year increase of 0.9%. This was followed by the United States with 59,570, Japan with 50,260, South Korea with 20,678 and Germany with 17,322. Judging from the ranking of applicants, Huawei Technologies Co., Ltd. topped the list with 69.52 million applications, and has been top of the list for five consecutive years. Huawei vice chairman and CFO Meng Wanzhou introduced that Huawei continues to increase R&D investment. In 2021, the company will invest 142.7 billion yuan in R&D, accounting for 22.4% of its annual revenue. From 2011 to 2021, Huawei's cumulative R&D expenses exceeded 845 billion Yuan. The "EU 2021 Industrial R&D Scoreboard" shows that Huawei's R&D investment ranks second in the world. Huawei is one of the largest patent holders in the world. As of December 31, 2021, Huawei has a total of more than 45,000 valid authorized patent families (over 110,000) worldwide, and more than 90% of the patents are invention patents. About 107,000 people work with developers, accounting for 54.8% of the company's total. According to statistics from statista, a data statistics agency, Huawei still tops the list with a 15.4% share in the 5G patent rankings, as shown in figure 3.

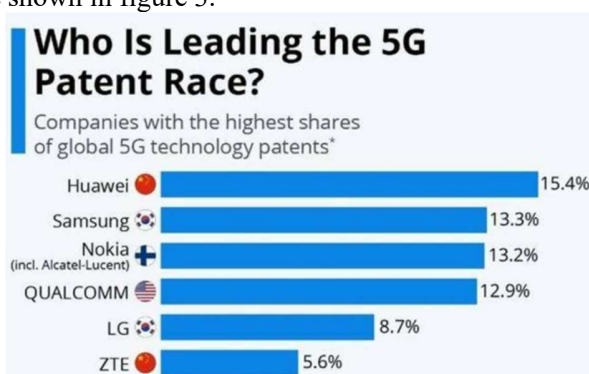


Figure 3: Global 5G patent proportion (Data source: IPlytics)

For operators around the world, Huawei is not only an equipment supplier, but also provides a comprehensive solution including patents. Communication operators who choose this solution also avoid a lot of patent risks. For those manufacturers who did not choose Huawei equipment, for example, Verizon, the largest communications operator in

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the United States, was sued by Huawei for infringing 230 patents and was required to pay \$1 billion in compensation. According to the 2021 Global Technology R&D Scoreboard, Huawei's R&D investment in 2021 will reach 17.46 billion euros, ranking second in the world after Google's parent company ALPHABET.

At Huawei Developer Conference 2021 (Cloud), Huawei Cloud released 6 innovative products and services: CCE Turbo cloud container cluster, CloudIDE intelligent programming assistant, GaussDB (for openGauss) database, trusted intelligent computing service TICS, Huawei Cloud Pangu A series of large models and basic software for diversity calculation.

HUAWEI CLOUD has achieved impressive results in 2021. According to the latest IDC report, HUAWEI CLOUD Stack has ranked first in China's software-defined computing (SDC) software market for four consecutive quarters, and ranked first in China's cloud management software for the fifth consecutive year. It ranked first in China's desktop cloud software market for the sixth year. HUAWEI CLOUD Stack has served more than 4,000 government and enterprise customers in more than 150 countries around the world.

(2) OPPO company

As of December 31, 2021, OPPO's global patent applications exceeded 75,000, and the global number of authorized patents exceeded 34,000. Among them, 5G communication standard patents have completed 4500+ global patent applications. A list of "China's Leading Companies in Patent Capability" shows that between 2017 and 2021, OPPO's patents ranked second only to Huawei. There are more than 2,600 AI OPPO patent applications worldwide; 9,831 image patents have been applied globally; about 3,390 patents in the field of fast charging have been applied globally, and about 1,786 have been authorized in total. More importantly, OPPO did not keep these patents at the digital level, but actively applied them to the product level to help end products continue to be high-end. In addition, OPPO won the fourth place in global smartphone shipments in 2021. In 2021, OPPO mobile phone images will have RGBW image fusion unit technology and continuous optical zoom. In addition to fast charging technology, OPPO will also introduce safety batteries, etc., to ensure the safety of mobile phone batteries to the end. In recent years, OPPO has continuously improved its R&D strength and innovation level, and has also achieved good results. In the 5G field, OPPO has continued to deploy 5G communication standard patents in more than 30 countries and regions around the world, completed a total of 4500+ family global patent applications, and declared 1800+ family 5G standard patents in ETSI.

3.3. Analysis of the status quo of patent transformation and development of typical enterprises

From the patent applications and development status of State Grid, Sinopec, Huawei and OPPO analyzed in section 3.1 and 3.2, it can be obtained that the number of patent applications of the four companies is measured according to the date of publication. The details are shown in figure 4.

From the above figure, we can see that the development of the two state-owned enterprises State Grid and Sinopec has the following characteristics compared with the patent volume of other enterprises. First, Huawei and State Grid have significantly more

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patent applications than the other two companies. Second, from 2013 to 2016, Huawei

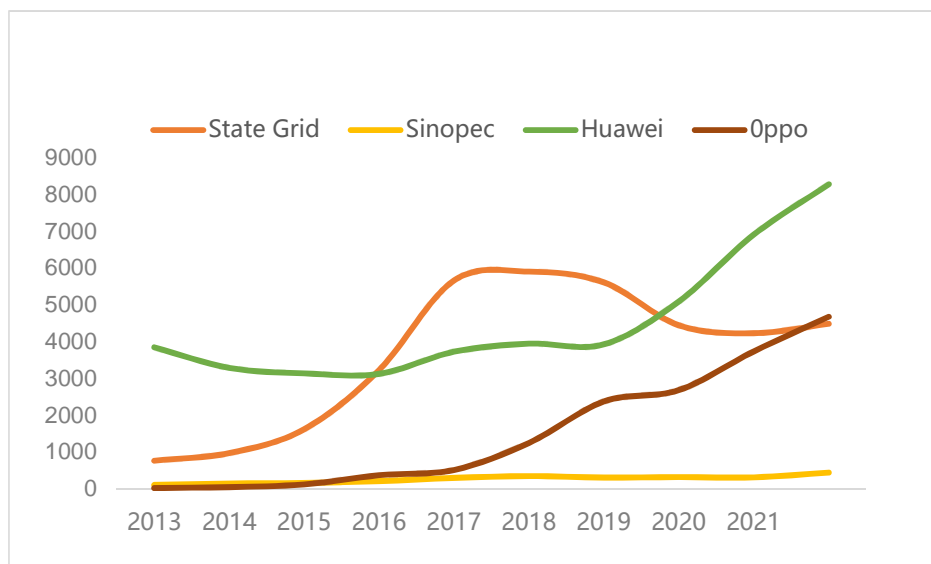


Figure 4: Increasing trend of focal enterprises

was the two companies with the most prominent patent changes among the four typical companies, Huawei and State Grid, and had an absolute leading position. The development of Huawei's patent applications has been relatively stable, and the development of State Grid Corporation has continued to increase. This is because companies have begun to attach importance to patents, so the number of applications has also increased. Third, from 2016 to about 2020, the State Grid Corporation of China has sought out Huawei for patent applications. Encouraged by national policies, state-owned enterprises attach importance to patents and produce a lot of output. Fourth, since 2020, the growth rate of Huawei's patent applications has once again surpassed that of the State Grid. The impact of the Meng Wanzhou incident has once again confirmed Huawei's path to patent research and development. The steady and upward development of patent applications is conducive to the sustainable development of enterprises, which is one of the reasons why State Grid and Huawei have become the first in the development industry among many Chinese enterprises.

4. Calculation of patent self-sufficiency rate of typical Chinese enterprises

Usually, the patent self-sufficiency rate, that is, the proportion of the patent output in the current year to the patent consumption in the current year, can measure the patent security level of an enterprise. In other words, the extent to which patent self-sufficiency is achieved depends on patent licensing. Since the patent research and development to the product cannot be completely measured by a patent, in order to quantify the patent production and consumption more accurately. This paper uses the ratio of patent R&D expenditure and patent income to measure the ratio of output and consumption of enterprise patents. It is generally believed that an enterprise's patent self-sufficiency rate is more than 100%, that is, it is completely self-sufficient; if it is 95% to 100%, it is basically self-sufficient; if it is

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90% to 95%, it is an acceptable level of patent security; if it is less than 90%, there is a risk of patent supply and demand increase.

$$P_i = \frac{R_i}{C_i} \quad (1)$$

In formula (1), P_i represents the self-sufficiency rate of an enterprise's patent in year i , R_i refers to the income brought by an enterprise's patent in year i , and C_i is the expenditure of an enterprise's patent in year i .

We apply the calculation formula (1) to calculate the patent self-sufficiency rate of the four focused companies, which are State Grid and Sinopec as two stated-owned enterprises, and Huawei and OPPO as two private companies. The calculation results are shown in figure 5.

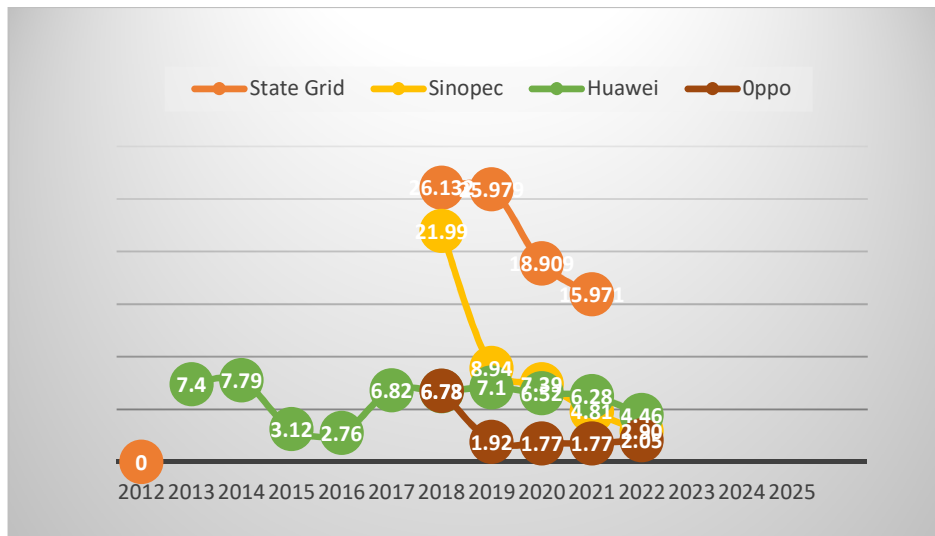


Figure 5: Enterprise patent self-sufficiency rate

4.1. Calculation results of Chinese company's patent self-sufficiency rate: for state-owned enterprises

(1) For State Grid company

According to Figure 7, it can be obtained that the State Grid Corporation of China did not disclose it in 2016 and before, so the obtained patent self-sufficiency rates from 2017 to 2020 were 26.13%, 25.97%, 18.9%, and 15.97%. The self-sufficiency rate that can be obtained is quite high, which may be related to the fact that the State Grid Corporation is a typical state-owned property. In addition to the company's own profit, the source of funds for the company also has support from the state. According to State Grid's future planning and the status quo of enterprise patent development, it can be obtained that State Grid not only has many technological innovations, but also attaches great importance to intellectual property work. State Grid Corporation is based on quantity and quality." The number of patents is large, and the most important thing is high quality and effectiveness.

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(2) For Sinopec company's patent self-sufficiency rate

According to Figure 7, it can be obtained: Sinopec's patent investment quota was not disclosed before 2016, so the patent self-sufficiency rates from 2017 to 2021 were 21.99%, 8.94%, 7.39%, 4.81%, and 2.9%. The patent self-sufficiency rate that can be obtained from Sinopec is much lower than that of the State Grid. Although Sinopec's patent application ranking is relatively high, the improvement of technology needs to be strengthened. With the increasing difficulty of technological development in the petrochemical industry, the patent self-sufficiency rate of the industry is decreasing. It is expected that you will get a greater degree of development in the later stage of the strengthening of patent investment in the future.

4.2. Calculation results of Chinese company's patent self-sufficiency rate: for private enterprises

From 3.3, it can be known that among the six companies of State Grid, China State Construction, Sinopec, Huawei, BOE, and OPPO, Huawei's development is more prominent in terms of patent growth and growth rate. Therefore, this paper uses Huawei as a typical enterprise to study the income and patent R&D costs brought by Huawei's patents to study the patent self-sufficiency rate of typical enterprises.

(1) For Huawei company's patent self-sufficiency rate

According to Figure 5, it can be obtained that Huawei's patent self-sufficiency rate is relatively stable according to Huawei's annual report. The patent self-sufficiency rate from 2013 to 2021 was 7.40%, 7.79%, 3.12%, 2.76%, 6.82%, 6.73%, 7.1%, 6.52%, 6.28%, and 4.46%. It can be obtained that Huawei's patent self-sufficiency rate is relatively stable. Huawei, as a model enterprise of patent research and development of Chinese private enterprises, ranks first among private enterprises with patent investment. Huawei is constantly exploring new fields, and it has invested more and produced more. In 2021, China Mobile announced the results of its network equipment tender, with Huawei winning the second largest 5G order of the year. Subsequently, the five major 5G network equipment manufacturers in the Chinese market reshuffled, with Huawei occupying the first place, see figure 6. Similarly, according to the announcement regarding 2021 top 10 "500 invention patents of private enterprises" released by China Federation of Industry and Commerce, Huawei also ranked the first, shown in figure 7.

Based on the information shown in figure 6 and figure 7 we can know that, Huawei has the largest number of innovation patents including 5G, 6G, automobiles, smartphones, and so on. According to current news, the number of 5G base stations in China has exceeded 70% of the global number of base stations. According to a Trend Force report, Huawei is the largest supplier of mobile base station equipment in the global market, with a 30 percent share. On March 16, 2021, Huawei released the latest white paper on intellectual property rights. At the same time, it announced the charging standards for 5G mobile phones for the first time. In April 2021, Huawei released its first-quarter financial report. The brightest data in the financial report was that it received a patent license fee of US\$600 million from a single customer. On July 7, 2021, Huawei and Volkswagen Group suppliers reached a patent license agreement, which includes Huawei's 4G standard essential patent (SEP) license, covering all Volkswagen vehicles equipped with wireless connectivity. The agreement is Huawei's largest licensing deal in the automotive sector to

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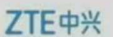

Market share distribution of 5g main equipment in China			
Ranking	Equipment manufacturer	number of base stations	Market share
1	 HUAWEI	703528	58%
2	 ZTE中兴	376785	31%
3	 ERICSSON	66648	6%
4	 大唐移动 DTmobile	38364	3%

Figure 6: Market share distribution of 5G main equipment in China

2021 top 10 of "500 invention patents of private enterprises"		
Serial number	Enterprise name	Province
1	Huawei	Guangdong Province
2	tencent	Guangdong Province
3	Midea Group	Guangdong Province
4	Baidu	Beijing
5	Zhuhai Gree	Guangdong Province
6	Haier Zhijia	Shandong Province
7	Sany group	Hunan Province
8	Xiaomi communication	Beijing
9	Beijing Qihoo	Beijing
10	Alibaba (China)	Zhejiang Province

Figure 7: Top 10 private enterprises with invention patents in 2021

date. On July 12, 2021, Huawei and Verizon, the largest wireless communication operator in the United States, reached a settlement in two patent infringement lawsuits. As early as February 2020, Huawei sued Verizon for unauthorized use in computer networking, download security, and video communications. More than a dozen Huawei patents are used. In December 2021, Huawei signed a Wifi6 patent license agreement with Japan's Buffalo (Buffalo) company, which is the first Wifi6 patent license agreement signed by Huawei and an overseas company. From this, we can see that Huawei's R&D investment is relatively stable and ranks high. It is a model for the development of private enterprises, and it is worth learning and learning from other enterprises.

(2) For OPPO company's patent self-sufficiency rate

According to Figure 7, it can be obtained: OPPO has not disclosed in 2016 and before, so

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the obtained patent self-sufficiency rate from 2017 to 2020 is 6.78%, 1.92%, 1.77%, 1.77%, 2.0%. OPPO is a joint venture. As of 2020, OPPO has applied for more than 57,000 patents worldwide, and the number of authorized patents is 24,000. In addition to the invisible technical patents of the 5G communication standard, there is also the amazing water drop hinge on the Find N, which is the "magic" that closes perfectly but makes the crease disappear. The patent self-sufficiency rate is also increasing. Enterprises pay more attention to the quality of patents while focusing on the number of patents.

5. Conclusion

2022 is a year of significant development in China's patent field, and the patent self-sufficiency rate will become more and more standardized and reasonable. The specific manifestations are as follows:

First, in terms of legislation, the newly revised Patent Law will come into effect on June 1, 2021. The Interpretation of the Supreme People's Court on the Application of Punitive Damages in the Trial of Civil Cases of Intellectual Property Infringement The Regulations on Several Issues Concerning the Application of Law in Civil Cases of Patent Disputes Related to Drugs, etc., followed, making the development of patents gradually standardized.

Secondly, companies represented by Huawei and State Grid are increasingly focusing on investment in patented R&D technologies. In 2021, Huawei's R&D investment will reach 142.7 billion yuan, accounting for 22.4% of the annual revenue, and the accumulated R&D expenditure in ten years will exceed 845 billion yuan. According to relevant requirements, China plans to achieve a chip self-sufficiency rate of 40% in 2020 and 70% by 2025. The National Bureau of Statistics, the Ministry of Science and Technology and the Ministry of Finance jointly released the data in the "2020 National Statistical Bulletin of Science and Technology Funding Investment". In 2020, China's R&D investment reached a new high, and the investment intensity continued to increase. Among them, the pulling role of enterprises was further strengthened, and innovation momentum was accumulated for high-quality economic development.

Third, with the country's emphasis on the patent self-sufficiency rate, the R&D investment of enterprises has increased. The patent self-sufficiency rate of enterprises will also gradually increase, thereby consolidating the position of enterprises in domestic and foreign industries. The 2018 US sanctions against ZTE and the 2018-2021 Huawei Meng Wanzhou incident are good examples.

In short, compared with developed countries, the overall level of China's R&D is still large but not strong, and too many but not excellent. In the next few years, China should further guide the whole society to increase investment in research and development, especially in the field of forward-looking and applied basic research. China will further optimize the allocation of my country's R&D resources, highlight the enterprise-centered, market-oriented, and promote the deep integration of industry, academia, and research. China will further leverage the government's management advantages in R&D, strengthen the construction of the national innovation system, and deepen the reform of the scientific and technological system. The patent self-sufficiency rate of Chinese enterprises increases with the increase of R&D investment. The patent self-sufficiency rate will also become more and more standardized, which promotes the development of patent norms.

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Funding Statement. This work is supported by Shaanxi Provincial Education Department (20JK0415), the topic: Research on patent self-sufficiency rate and diffusion efficiency of Chinese enterprises based on curved case analysis ; Scientific Research Project of Xijing University Scientific Research Project (XJ190106), the topic: Research on the mode of "central bureau" of patent self-sufficiency rate in my country's supply chain.

Acknowledgement. The author is thankful acknowledge to the reviewers for their beautiful comments.

Conflict of interest. The authors declare that they have no conflict of interest.

Authors' Contributions. All the authors contributed equally to this work.

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