THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN CHINA UNDER THE 14th FIVE-YEAR PLANELECTRO

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China's economy has a difficult future ahead: the prevalence of protectionism, slowing economic growth, US attempts to curb China's technological progress, and trade frictions. This could lead to reduced trade flows in technology and other areas. To cope with this situation, the Chinese government has set guidelines for industrial and technological development in its 14th five-year plan. In this paper, we will discuss the current status and development trends of Chinese science and technology in the context of the current international situation, the current status of China's science and technology development, the plans for future development, and the possible advantages and difficulties.

Key words: technological advances;5G; new infrastructure.

РАЗВИТИЕ НАУКИ И ТЕХНИКИ В КИТАЕ В ПЕРИОД 14-ОЙ ПЯТИЛЕТКИ ПЛАНЭЛЕКТРО

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Экономику Китая ждет трудное будущее: преобладание протекционизма, замедление экономического роста, попытки США обуздать технологический прогресс Китая и торговые трения. Это может привести к сокращению торговых потоков в сфере технологий и других областях. Чтобы справиться с этой ситуацией, китайское правительство определило основные направления промышленного и технологического развития в своем 14-м пятилетнем плане. В этой статье мы обсудим текущее состояние и тенденции развития китайской науки и техники в контексте текущей международной ситуации, текущее состояние развития науки и техники Китая, планы на будущее развитие, а также возможные преимущества и трудности.

Ключевые слова: технологические достижения; 5G; новая инфраструктура.

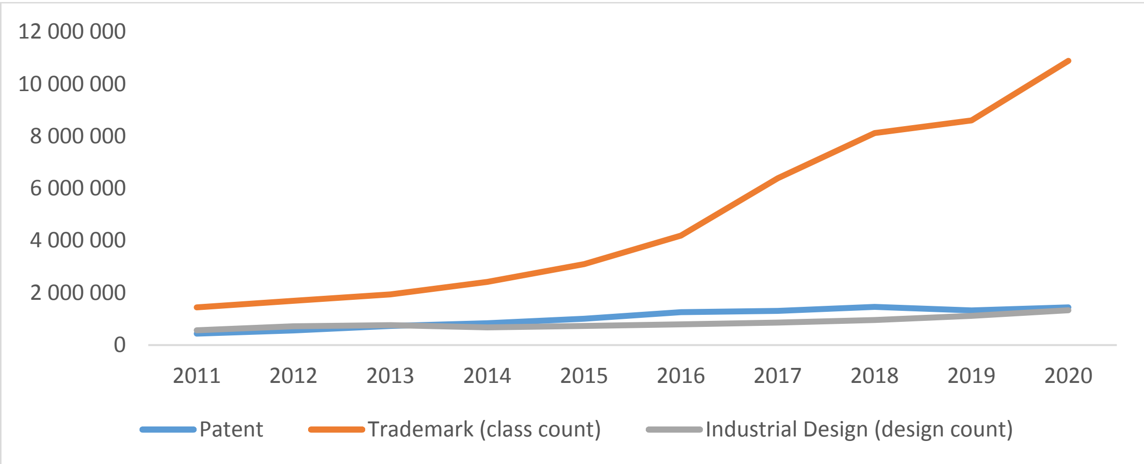
The current state of scientific and technological development in China

The reform of China's science and technology system originated in 1985, 36 years ago, while the recovery of Chinese higher education began in 1977, 44 years ago.

Through these years, the number of undergraduate students enrolled in China has risen from 270,000 in 1977 to 9,675,000 in 2020, while according to the statistical analysis of the China Institute of Scientific and Technological Information: in 2019, China published 59,867 high-quality international papers, accounting for 31.4% of the world share and ranking 2nd in the world; Among the world universities publishing the highest number of high-quality international papers, four Chinese universities are in the top 10: Tsinghua University, Zhejiang University, Shanghai Jiao Tong University and Peking University; And China ranks first in the world in the number of high-quality international papers in eight disciplines: engineering and technology, chemistry, environment and ecology, computer science, material science, agricultural science, physics and mathematics [1, p. 2].

From a technology perspective, China remained a net importer of technology between 1997 and 2010, the dates for which data are reported. net royalty and licensing payments in China were $511.5 million in 1997 and increased 20-fold to $10.57 billion in 2010. With such a large amount and a high growth rate of net payments, China is now the third largest net importer of technology in the world, behind Ireland and Singapore. The remarkable growth of net payments in China reflects the international exploitation of intellectual property rights, which has become increasingly important in China's growth in the era of globalization.

Driven by international technology diffusion and a surge in domestic R&D intensity, the number of patent applications in China has increased significantly, from 8,558 in 1985 to 1,497,159 in 2020. From a geographical point of view, China has had the number one patent office since 2015.The number of patent applications received by the State Intellectual Property Office of China in 2020 is 2.5 times greater than the number of applications received by the patent office of the United States of America (USPTO; 597,172), the second largest country. In addition, more than 95% of the patents granted to Chinese residents came from the Chinese Patent Office, while these local percentages were 58% and 66% for the US and Japan [2, p. 7].



Tab. 1. IP Filings
Source: WIPO statistics database; last updated:11/2021

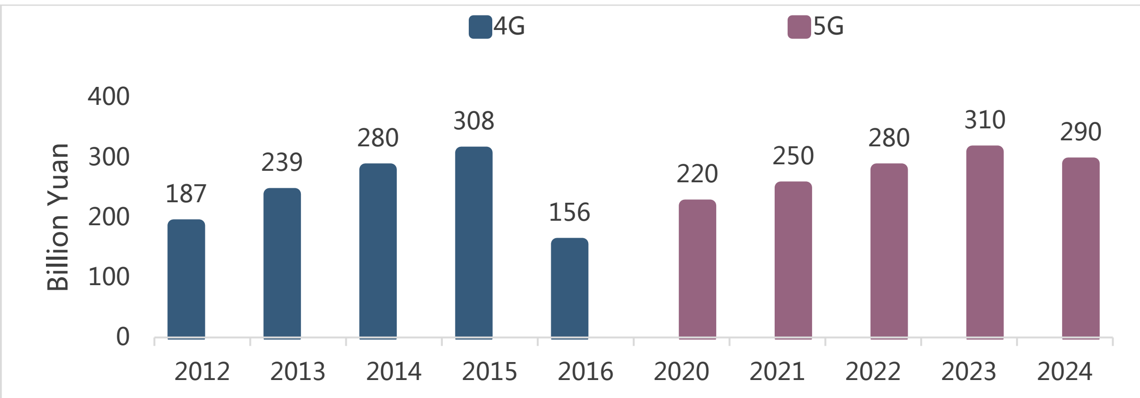
Trends in the future development of science and technology in China. China's five-year plan emphasizes policy direction for the next five years, with the emphasis in the 14th Five-Year Plan expected to be on raising the urbanization rate, increasing the weight of R&D in science and technology and consumption in the economy, as well as reducing carbon emissions and creating a more mature metal market. The growth of science and technology and high-tech industries will receive more attention [3, p. 8].

The Chinese government is working to shift GDP growth from export-oriented to domestic demand-driven in response to the cooling of global trade.

China's quest for self-sufficiency and leadership may be accelerated in the new five-year plan due to the ongoing U.S. containment of China's technological development. Key areas of focus are likely to include 5G, the Internet of Things (IoT), semiconductor core manufacturing, cloud computing and data centers.

The Chinese government seeks to make progress in global technology innovation and research and development in the «14-5» plan, particularly in the hope that 5G, data centers, and AI will lead the way in technology-driven growth over the long term. According to the data of China Center for Information Industry Development, China's new infrastructure investment could reach a maximum of 10 trillion RMB in 2021-25, with a possible multiplier effect of 17 trillion RMB on the supply chain [4, p. 8].

As part of the stimulus package, China is accelerating 5G grid investment in its new five-year plan starting in 2021. China is becoming the global 5G leader. According to China Mobile and its peers, 130,000 5G base stations were built in 2019, and more than 650,000 new base stations will be built in all of 2021. The 5G stimulus is likely to drive China's technology position upward, igniting its ambition to lead global technology innovation and R&D, compared to the declining returns of more mature, traditional heavy infrastructure such as high-speed roads and railroads.



Tab. 2. China 5G grid investment plan
Source: China Academy of Information and Communications Technology

The severe skills shortage and the Chinese government's determination to close the semiconductor production technology gap in the short term means that China's own state-of-the-art IC process technology will develop rapidly, with manufacturers and semiconductor design houses expected to thrive, and foundries likely to upgrade their production technology and equipment to meet 70% of the chip production target.

Cloud technology and data centers will also see rapid growth due to the Chinese government's blanket support for the digital economy and its push to build Internet data centers (IDCs) to reduce dependence on U.S. technology supplies. China's government incentives will provide a strong incentive to Chinese server manufacturers and IDC operators, potentially even creating a technology and supply glut.

The closure caused by the coronavirus outbreak in China in late January and February 2020 exposed China's lack of preparedness for telecommuting. As a percentage of total IT support alone, China lags behind the U.S. and global averages, so China is prioritizing cloud investments in its new five-year plan to minimize future business disruptions caused by tail risk events. According to IDC, cloud infrastructure and software will account for only 19.6% and 24.8% of total hardware and software spending in 2020, compared to global averages of 22.1% and 31.9%, respectively, and 24.4% and 37.8% in the US [5, p. 5].

Possible advantages and difficulties. China has certain advantages in the global development of technology, such as the large scale of the hardware assembly sector, as well as strong e-commerce, online payment and e-banking systems.

In addition, the growing demand for ultra-fast wireless networks during the pandemic may also drive the development of 5G technology in China. But to prosper, China will need to invest money, time, energy and talent, as well as global recognition to buy its design and supply chain products.

At the same time, China has an AI core R&D advantage due to its large population and market, and Chinese AI core design companies such as Hense Semiconductor and Cambuji enjoy more resources to build a competitive advantage compared to their foreign counterparts. These companies have access to a database supported by the world's largest population size and the fastest growing penetration of smart phones and security cameras. Such a large database provides companies such as Huawei and Baidu with a broad data set to develop AI algorithms. In addition, edge computing relies on specialized integrated circuits (ASICs), which are less difficult to design than field-programmable gate arrays (FPGAs) and graphics processing units (GPUs), thereby lowering the barriers to entry for newcomers to the chipset market.

According to Gartner, demand for smart cars and security cameras in China may drive the domestic semiconductor industry to grow at an annual rate of more than 17% over the next three years. Smart cars and security cameras are two of the most important application scenarios for AI core products.

However, the disadvantage is clear: a large number of non-Chinese companies provide the basic building blocks for the technology industry, and China cannot do without these products. Cellular network chips for 5G and the high-performance advanced processors used in smartphones are key technologies that will take China years to produce without U.S. and U.K. expertise. China will not be able to move forward without a license to use the intellectual property of the Amos processors.

An Mou, Intel and Qualcomm have key intellectual property and decades of experience in iterating across device technologies. Without this IP, it could take years for China to create such expertise.

And in the area of memory chips, even with Chinese government subsidies, it will be difficult for Chinese companies to catch up with experienced foreign companies such as Armored Man, Micron Technology, Samsung Electronics, SK Hynix and Western Digital due to the gap between the volume and cost of memory chips.

In the field of chip manufacturing equipment and services, it is currently dominated by American, Taiwanese and Japanese companies. In the field of chip foundry services, SMIC, the largest foundry company in mainland China, is far behind its competitors in reducing the size of transistors, and this technology is the key to development.

And on the software side, operating systems have been a constraint on the development of Chinese smartphones, with any low-cost phones that could potentially replace Apple's iPhone relying heavily on Google Inc.'s Android operating system. After being blacklisted by the U.S. in 2019, Huawei has no ties to Android. If Huawei and other Chinese companies end up having to increasingly rely on a homegrown operating system like Huawei Hongmeng, it will not only be time-consuming, but the user experience will also be greatly diminished. It would be especially difficult to develop a common operating system that could be adopted by multiple smartphone vendors. Moreover, the development of a local system would also face the possibility of conflicts with Google and Apple's intellectual property rights.

In summary, we have described China's scientific and technological achievements since the early 1980s, analyzed the areas of scientific and technological development that will affect China in the coming years under the 14th Five-Year Plan, and predicted the trends in scientific and technological development, as well as possible strengths and weaknesses. It is concluded that China is still in the process of rapid development in science and technology, although there are a lot of shortcomings, and due to the policy incentives of the Chinese government, the fields of 5G, Internet of Things (IoT), semiconductor cores, cloud computing, and data centers will see rapid development in the coming years, while semiconductor cores and smartphone operating systems will need to be prepared to lag behind for a long time due to the large technological gap. The conclusion is that we need to be prepared to lag behind for a long time to catch up.

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