Technology for Markets in the Chinese Telecom Equipment Industry

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Edited by
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Abstract

In less than fifty years, the People's Republic of China has managed to become ranked among the most powerful nations in the world from a technological point of view, even reaching the cutting edge technology in sectors as relevant as telecommunications, currently having global influence with high geopolitical relevance. In that sense, China's leadership in technologies such as 5G and Artificial Intelligence (AI), in addition to its purchasing and financing capabilities, give the mainland a big chance to dispute different scenarios that until recently were reserved only for the great Western powers and their allies.

The path that the Chinese state has followed to set up its current knowledge of technology has been ideologically based on the 'Four Modernisations'. Its sustained growth had to do with the route map given by the successive Five-Year Plans and a deliberate action stressed by the rigorous 'markets for technology' trade off that has offered to developed countries.

The turnaround in the Chinese economy promoted by Deng Xiaoping – 'The Little Helmsman' – based on market oriented reforms has allowed the country to achieve the great transformation by using some tools of the capitalist system, far from those to the dogmatic communism.

Thus, during the last years of the twentieth century, China took a hit of technology transfer in exchange for opening its markets to foreign competition. This situation was exploited by Chinese industry to quickly achieve its own capabilities for innovation and technology development. Starting in 2001, China joined the WTO and has ridden the wave not only to increase its technological capability but also to become a leading competitor in high value-added manufacturing. Thanks to the use of its large domestic markets as an attractive currency of exchange.

DOI: 10.4324/9780367565152-RECHS39-1

Keywords: Technology development; Geopolitics of technology; Telecom equipment industry; Global markets

1 Introduction

China's economic revolution tapped into the potential of its domestic market. Once Mao's times ran out, the Chinese state understood the enormous potential that the country had as a market for the capitalist model and they got down to work: the promise of a vast domestic market to exploit, the government's intention to improve the material conditions of millions of people, the amelioration of the infrastructure for production, plus the huge advantages in labour costs were the perfect combination for the great powers to contribute heavily to Chinese development.

The push that the great powers have given China to move forward has been strongly encouraged by the opening of their local markets. This topic has become very clear in technology markets. In this sense, the first entries (still very restricted) of high-tech consumer goods and equipment occurred at the beginning of the 1980s, precisely to modernise the Chinese economy.

This first stage was followed by the creation of joint ventures between local companies and the world's leading companies in specific high-tech sectors. Based on this scheme, Chinese companies sought to absorb enough skills and knowledge to generate their own development and production capabilities. Finally, in a third moment, the development of high-tech products with Chinese intellectual property rights began, with the aim of achieving world leadership in its manufacture and supply.

2 Joint ventures and development support programs

The strategy of carrying out joint ventures has turned out to be very effective for the subsequent capture of international markets by Chinese high-tech manufactures. This instrument was very attractive for large foreign firms, which could acquire a shareholding of up to 40% in a local manufacturing company, supply mainland markets – virtually virgin and captives- and also produce goods for the rest of the world with an attractive cost advantage – based on low wages.

From the local point of view, the Chinese counterpart retained 60% of the company's shares, ensuring control of the business and technology transfer. That way, if an effective absorption of knowledge was achieved, they paved the future of a domestic industry with its own capabilities. The Chinese government did not leave this last aspect to chance and attended it with development policies in S&T and education.

The main programs carried out by the State Science and Technology Commission (SSTC), which later became MOST (Ministry of Science and Technology), were Program 863, 973 and the Torch. The 863 Program aimed at the development of sectors with a high-tech aggregate, the 973 Program (also known as the National Basic Research Program) had the purpose of promoting basic science, while the Torch Program complemented the previous ones by addressing the strategy of marketing of Chinese high-tech production and R&D.

Program 863, or State High-Tech Development Plan, was one of the pillars of the implementation of the 'Four Modernisations'. The Four Modernisations were goals originally outlined in 1968 and later set forth by Deng Xiaoping in the early 1980s, to strengthen the fields of agriculture, industry, national defence, and science and technology.

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Program 863, so named because it was launched in March 1986, aimed to minimise China's dependence on foreign supplies of high value-added equipment. Initially it was focused on biotechnology, space activities, IT (information technology), laser technology, automotive industry, energy and new materials. In a second stage in 1992, telecommunications equipment was included (Gong & Wang 2007).

The main reason for that inclusion had to do with the dominant idea of the Chinese government about the necessary access of the country's economy into the 'Third Wave', in the 'Information Age'. To do this, it must promote and develop not only the microelectronics industry, considered the basis of the information industry, but also must dominate telecommunications technology.

The 863 Program comprised the so-called Tele 863, which worked in its first ten years to achieve dominance of 3G mobile communications technology; after that, Tele 863 was committed to technologies beyond 3G. During those years there were very important domestic advances, which even allowed the Chinese to implement their own 3G mobile technology standard (TD-SCDMA or simply TD). On the other hand, they were able to develop the entire telecommunications value chain, from its base in the production of semiconductors to the provision of telephone and data services.

3 Building indigenous technology skills: the switches market

The starting point for the local development of the telecommunications industry were switches. Once the essential imports to update the systems were made, the Chinese industry sought to generate their own capabilities. By the late 1980s, the high costs of importing equipment (such as digital telephone exchanges) were beginning to put pressure on the balance of payments. China then decided to accelerate the drive toward technology absorption.

The creation of joint ventures to produce switches allowed the world leaders equipment companies to start manufacturing in China and to compete in the Chinese markets; in return, local firms obtained access to technology for the production of high-capacity telephone exchanges. This strategy is known as 'Technology Transfer in Exchange for Domestic Markets' (TTEDM), targeting foreign direct investment (FDI) (Huang 2006).

In 1983, the first big company attracted to the Chinese-proposed deal was BTM, a Belgian subsidiary of ITT (USA), which founded Shanghai Bell. In 1987, Shanghai Bell was taken over by Alcatel (France). This firm dominated the national switch market until the end of the 1990s, competing with other equipment production joint ventures formed by large companies in the sector: NEC (Japan), Siemens (Germany), Ericsson (Sweden), AT&T (USA) and Nortel (Canada) among the most relevant (IGI Consulting 1997; Harwit 2008).

Starting in 1996, the Chinese government ended special policies for importing switches, giving place to a more explicit 'buy local' policy. Even then, a critical knowledge base already existed to meet the local demand with switches based on production and supply chain stated as 'Made in China'.

Local firms that emerged years ago, such as Huawei, ZTE and Great Dragon, quickly began to gain market share in the telecom equipment industry. In addition, future sales expectations made it possible for them to pour large sums of money into research and development, with the aim of designing their own products based on indigenous patents. China was becoming less dependent on great powers for telecommunications technology.

Huawei founder Ren Shengfei is credited with having a major influence on the Chinese government's decision to move forward with 'buy local' telecommunications equipment: in a

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1994 meeting with Jiang Zemin, then General Secretary of the Chinese Communist Party, Ren would have stated that 'switching equipment technology was related to national security, and that a nation that did not have its own switching equipment was like one that lacked its own military' to which Jiang agreed (Harwit, 2008: 127).

4 Intellectual property and access to global markets

Starting in 2000, two parallel events strengthened the position of Chinese technology in telecommunications. On the product development side, Chinese companies reached a high level of knowledge and began to add their own patents. Thus, since 1999 the Chinese telecommunications standardisation body, the CWTS, agreed to participate in the 3GPP international consortium, where standards were discussed worldwide.

Although this event is based on the progress that Chinese firms had achieved in wireless technology, it can also be taken as a kind of trade-off between the European industrial conglomerate (which ruled the standards at that time) and the Chinese government. The agreement made it possible for Europeans to penetrate a very attractive market with their products, with a potential of more than 1,000 million inhabitants. On the other side, it allowed the then infant Chinese telecommunications industry to be part of the big decisions of global impact in terms of markets.

The other important event regarding the market relevance of Chinese equipment production was China's entry into the World Trade Organization (WTO). The Asian country signed its inclusion in the international organisation on 11 December 2001, which meant the opening of more markets for Chinese products. In exchange, there was also a liberalisation of the mainland markets: the foreign competition was admitted without limitations and the restrictions on foreign ownership in local firms were removed (Huang 2006). The timing to take this step has been appropriate, since it has found the Chinese industry modernised and in good conditions to compete globally.

The new conditions encourage large technology companies to invest and develop new products in China. Foreign firms could produce in the large Chinese technology centres – such as Beijing, Shanghai, Shenzhen and/or Guangzhou – while retaining control of business management and without the need to transfer technology. This latter condition made it possible to generate environments favourable to innovation, spurred on by the Chinese education system, which as of 1999 experienced a deep transformation: university education ceased to be only for an elite and became massive, generating a sustained growth in graduates, especially in STEM (Science, Technology, Engineering, and Mathematics) careers.

Based on the above-mentioned conditions, China has not stopped growing in the production of patents. According to the records of the World International Patent Office (WIPO), in the Patent Cooperation Treaty (PCT) China ranked 17th among the countries that had filed the largest number of patents in 2000; five years later (2005) it ranked eleventh, while in 2020 it has reached first place in patent applications, displacing the United States, which historically was the country with most registrations each year.

From the analysis of PCT records, it also emerges that Huawei Technologies is the firm that has filed the most patents annually between 2014 and 2020, reaching more than 5,000 applications per year. In addition to Huawei, the Chinese representation among the twenty companies that have registered the most patents in 2020 includes 4 other firms: Boe Technology, Guangdong Oppo Mobile, ZTE Corporation, and Ping An Technology.

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Overall ranking	Change in position from 2019	Applicant	Origin	Published PCT applications		
				2018	2019	2020
1	0	HUAWEI TECHNOLOGIES CO., LTD.	China	5,405	4,411	5,464
2	1	SAMSUNG ELECTRONICS CO., LTD.	Republic of Korea	1,997	2,334	3,093
3	–1	MITSUBISHI ELECTRIC CORPORATION	Japan	2,812	2,661	2,810
4	6	LG ELECTRONICS INC.	Republic of Korea	1,697	1,646	2,759
5	–1	QUALCOMM INCORPORATED	U.S.	2,405	2,127	2,173
6	1	TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)	Sweden	1,645	1,698	1,989
7	–1	BOE TECHNOLOGY GROUP CO.,LTD	China	1,813	1,864	1,892
8	–3	GUANG DONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD	China	1,042	1,927	1,801
9	4	SONY CORPORATION	Japan	1,342	1,566	1,793
10	2	PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.	Japan	1,465	1,567	1,611
11	3	HEWLETT–PACKARD DEVELOPMENT COMPANY, L. P.	U.S.	1,170	1,510	1,595
12	3	MICROSOFT TECHNOLOGY LICENSING, LLC	U.S.	1,476	1,370	1,529
13	–4	ROBERT BOSCH CORPORATION	Germany	1,525	1,687	1,375
14	–3	LG CHEM, LTD.	Republic of Korea	969	1,624	1,374
15	12	NIPPON TELEGRAPH AND TELEPHONE CORPORATION	Japan	138	703	1,372
16	2	ZTE CORPORATION	China	2,080	1,085	1,316
17	–9	PING AN TECHNOLOGY (SHENZHEN) CO., LTD.	China	336	1,691	1,304
18	–1	SIEMENS AKTIENGESELLSCHAFT	Germany	1,211	1,153	1,202
19	–3	FUJIFILM CORPORATION	Japan	962	1,158	1,128
20	0	NEC CORPORATION	Japan	947	1,024	1,121

Figure 1: Top PCT Applicants

Source: WIPO (2021).

5 Chinese advances resulting from global rise of wireless technology

The local change in the rules of the game in the early 2000s also opened up the possibility for Chinese technology firms to leverage their progress by trading off 'technology for markets' through new cooperation agreements. In this sense, the telecommunications equipment industry used this scheme to meet the demands of wireless networks. One of the examples has been Huawei, which signed an equipment supply contract with the microelectronics business unit of IBM (United States), specialised in integrated circuits and software. As compensation for this contract, IBM gave Huawei access to its research laboratories (Gilley 2000).

The growth that Huawei has shown on the mainland has been very attractive to multinationals, who have sought to partner with the company to advance in the Chinese market. Thus, the Shenzhen-based firm has been able to close commercial agreements with the main equipment manufacturers, such as Lucent, AT&T, and Intel, for the development of network infrastructures.

In order to access to the mobile telecommunications and wireless communications market, Huawei established a number of working agreements supported by a series of joint R&D facilities, with partners such as Texas Instruments, Intel, Altera, Cisco Systems, Infineon, Microsoft, Motorola, Qualcomm, and Sun Microsystems among others. The knowledge that Huawei was acquiring then allowed it to join the meetings of the International Telecommunications Union (ITU), where the standards for the industry are discussed.

In the following stage, Chinese telecommunications technology companies partnered with different multinationals for the deployment of mobile telephone networks, and particularly for

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the development of the 3G standard, TD-SCDMA. Thus, CATT/Datang Mobile joined with Siemens (Germany) for the construction of the TD-SCDMA standard; later the German firm joined with Huawei to market it.

The commercialisation of TD-SCDMA was assigned by the Chinese government to its largest mobile operator, the state-owned company China Mobile. Several consortia of companies participated in the network bids, all of them were made up of a local company and a large telecommunication equipment multinationals. Thus, the Datang consortium included Alcatel-Shanghai Bell (France), the ZTE consortium included Ericsson (Sweden), Huawei joined with Siemens and the Potevio firm bid together with Nokia (Finland) (Stewart et al. 2011).

The outline for the next generation of mobile networks – 4G/LTE – has found the Chinese firms Huawei and ZTE competing at the same level as the big world companies. During the 2010s, the network equipment market experienced a series of mergers involving the big players in the sector. As a result, only a few companies have remained on track, facing a new reality marked by the Chinese offer of a very competitive quality-cost ratio.

The global firms that managed to stay ahead of the market have been Nokia, Ericsson and Samsung. Nokia achieved from 2010 to 2016 to first take over Motorola's network equipment business, then bought Siemens' mobile phone business, and then absorbed Alcatel-Lucent. At the same time, Ericsson has focused on the equipment market, buying the network division of Canada's Nortel (now defunct) and leaving its cell phone business. While Samsung emerged as a global player from a conglomerate integrated throughout the entire value chain: the Korean holding (*chaebol*) dominates the sector from the production of semiconductors to the provision of streaming services.

Given the start of 5G deployment networks around the world, the telecommunications equipment market is concentrating 80% of its total global sales of 2G, 3G, and 4G technologies in just 3 providers. Thus, Huawei heads the list with 31% of the share, followed by Ericsson (27%) and Nokia (22%). Further, the Chinese firm ZTE (11% share) and the South Korean Samsung (5%) participate with significant portions. (reference). These figures are considered the basis of market share for each of the providers, since the telecom operators normally maintain long-term relationships with them.

6 Conclusions

The path taken by the Chinese government from Deng Xiaoping to Xi Jinping has shown clear traces of the purest pragmatism based on the logic of capitalism. Thus, in the first stage, it can be pointed out that, once the basic economic structures of industrial China were modernised, the country took advantage of its large internal markets and its very low wages to exchange them for technological knowledge. In a second stage, China has sought (and succeeded) in sharing knowledge to consolidate its innovation system, always attracting its counterpart by opening its internal markets. Already in a third moment, high technology designed and manufactured in China can compete with its former mentors in a globalised market.

This *modus operandi*, which has been exemplified from the analysis of the telecommunications equipment sector, can be seen replicated in other industries, and in all cases the fascination of the potential demand of a giant market such as the Chinese market is incontestable for a capitalist economy.

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Today, with China emerging as a competitive economic power, based on a largely homegrown technology base, backed by (supporting) global value chains, the world's major economic powers would be more reluctant to accept China's prior proposed trade-off. It will then be expected that Chinese markets for the West will be limited and that technology transfer activities to the mainland will be restricted and/or hindered: the Chinese semiconductor industry could be one of those affected in the short term.

Faced with this new reality, the geopolitics of technology comes into conflict with the markets for goods and services. The question is simplified to assessing how much of the market the West (and their great powers) is willing to lose in favour of maintaining its technological leadership.

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DOI: 10.4324/9780367565152-RECHS39-1