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Chapter 2. Formation of the dual innovation systems in China

Xielin Liu, Xiao Wang, Yimei Hu, and Xinzhi Chang

Based on the concept of the innovation system, some researchers introduced the term ‘dual innovation system,’ which means the simultaneous innovation of a product and a technology to be applied in that product (Brilhuis-Meijer, 2016). In China, the government intervenes considerably in some industries, with the purpose of facilitating a catch-up strategy. In other industries, however, the market mechanism and the invisible hand play a more important role, allowing many private enterprises, such as Huawei and Lenovo, to innovate and to work within their own business models.

In China, there are two kinds of innovation systems: the national innovation system, which consists of such major players as the central government, SOEs, universities and governmental research institutes such as the Chinese Academy of Sciences (CAS); and the market-driven innovation system, composed of privately owned enterprises (POEs), regional industrial clusters, and global business networks. Sometimes the two kinds of innovation systems are complementary (e.g., in telecommunications); work separately (e.g., more POEs clustered in the wind power and photovoltaic industries, compared to SOEs); or even compete with each other (e.g., in the computer industry). Basically, the market-driven innovation system functions similarly to other innovation systems all over the world, whereas the national system is unique to China, especially in terms of how SOEs innovate and how the other actors interact with the SOEs. This is the focus of this book, sharing the stories of representative Chinese SOEs’ innovations and scrutinizing the key enabling factors and evolutionary processes of those innovations.

In this chapter, we use the term dual innovation system to capture a Chinese institutional phenomenon: the parallel operating innovation systems, one with state-owned enterprises (SOEs) and the other with private enterprise as the main actor. They have different ways of organizing innovation, industries with different focuses, different incentives and even different regional focuses. Therefore, the innovation pattern of SOEs and POEs actually has the characteristics of dual innovation. In other words, two innovation entities play an irreplaceable role in their respective fields, promoting and competing against each other in the unique Chinese national innovation system. As only a former socialist country in the transition process can make such a dual system work, it seems that it will last for a long time in China.

2.1 The Evolving Role of SOEs in Innovation Systems

Although Chinese privately owned enterprises (POEs) and foreign multinational enterprises play an indispensable role in some industries, such as IT (e.g., Huawei, Lenovo, Nokia, Motorola, Samsung, Ericsson, and AT&T), one can hardly neglect the powerful role that large SOEs undertake in implementing the national strategies in other industries, such as utilities, infrastructure, oil and banking. Even in the IT industry, the largest operators of mobile telecommunications are SOEs (China Mobile,

China Telecom, and China Unicom). These SOEs are expected to exemplify the value of government intervention in technological, economic, and societal development.

Following the example of the former Soviet Union, China deployed the socialist system and planned economy in 1949. Like other socialist economies, state-owned enterprises used to be the only legal entities conducting economic activities. From 1949 to the 1980s, the SOEs in various industries, such as steel, automobiles, machinery and railways, tried only to specialize in equipment and component manufacturing under the control of the central or local government (Liu & White, 2001). In 1978, when China initiated its economic reform and opening up, SOEs generated almost 80% of the industrial output and provided lifetime employment opportunities—i.e., the '*iron rice bowl*.' Nonetheless, the planned economy had proved to be less efficient than a market economy.

In 1978, the GDP per capita of China was insignificant, only 57 USD, compared to the UK (5,977 USD), Japan (8,675 USD), and the US (10,600 USD). The main reason for this discrepancy was that Chinese SOEs lacked global competence compared with the POEs in other countries' market economies. With the decline of the former Soviet Union, the appeal for privatization started to be a strong voice with regard to China's economic development and sustainability. In essence, privatization assumes that people are better motivated to develop privately owned ventures and to use resources more efficiently in the context of competitive markets (Majocchi & Strange, 2012; Megginson & Netter, 2001).

In the late 1990s, Premier Zhu Rongji implemented several radical measures to improve the SOEs' efficiency and to urge the transformation of SOEs. The first was deregulation, granting the SOEs more autonomy, followed by invigorating the large enterprises while reducing control over the small ones. After that, a further measure was to introduce market competition while decreasing the monopoly of SOEs, through splitting the large SOEs into two or more smaller ones. With the concurrent legitimization of POEs, some small SOEs were transformed into POEs, while some others were merged into large SOEs.

Since the global financial crisis in the late 1990s, SOEs have again become a major player in China's economy. Large SOEs supported by policy banks emerged as the leaders in implementing China's 'going out' policy through overseas direct investment (OFDI) with the purpose of acquiring[?] natural resources and market seeking. Meanwhile, in response to the indigenous innovation strategy, SOEs were expected to play a leading role in megaprojects such as High-Speed Rail, Nuclear Power Plant and Ultra-High Voltage Power Transmission. During the global financial crisis in 2008, the central government, led by the Hu-Wen Administration,¹ increased financial support to stimulate China's

¹ The *Hu-Wen Administration* represents the 4th generation of Chinese leadership. The phrase is named after the surnames of two leaders, the Party General Secretary and President Hu Jintao, and government Premier Wen Jiabao.

economy, most of which was allocated to giant SOEs for completing large-scale infrastructure projects. This, in turn, spurred the further expansion of these SOEs.

Chinese SOEs have multiple objectives, not just profit maximization. This is the main reason that Chinese SOEs are usually regarded as less efficient and slow in adapting to a market regime. This assumption is based on SOEs requiring a large volume of input without yielding the corresponding output (Hovey et al., 2003). Even so, up to this day, SOEs continue to play a key role in China's political economy after more than three decades of experimental and gradual reform. The clear message is that the Chinese government will not eliminate SOEs but, rather, will preserve them as long as possible.

The irreplaceable role of SOEs:

SOEs have strong implications for China's economy. SOEs benefit from direct and indirect subsidies in terms of production factors (capital, energy and land), regulatory preferences and public procurement, which allow them to maintain their dominant positions in the pillar industries of the national economy. Despite the mass expansion of the private sector during the later period of the Hu-Wen administration, SOEs remained a significant factor in China's economy in terms of output, profit and employment. In addition, in the past decade, mergers among SOEs became prevalent, such as the merger of China Metallurgical Group and China Minmetals Corporation, Baosteel Group and Wuhan Iron and Steel Group, and China North Railway and China South Railway. Thus, the number of large SOEs under SASAC (State-Owned Assets Supervision and Administrative Commission) fell from 196 in 2003, when SASAC was established, to only 96 in 2019.

The existing SOEs' overall productivity has continued to increase since the reform, and the gap of productivity between the SOEs and private-owned enterprises (POEs), as well as foreign investment enterprises (FIEs), has been narrowing. Figure Error! No text of specified style in document.-1 shows a sharp increase in SOEs' profitability in recent year, as well as a trend of FIEs' and POEs' profits catching up; and we have reason to believe that SOEs' total profits may even surpass FIEs' total profits in the future.

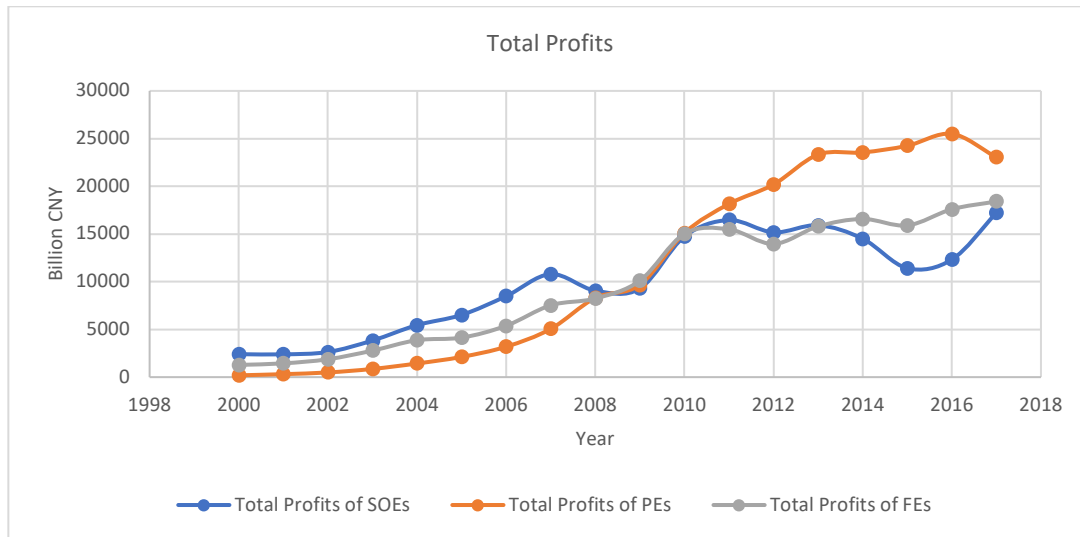


Figure Error! No text of specified style in document.-1. Total profits of different types of enterprises.

Source: Authors' calculation based on National Statistics Yearbooks of China.

The revenue achievements of SOEs can be seen in the 2019 list of Fortune 500 companies. Approximately 129 Chinese firms are listed, surpassing the U.S. (121 firms) for the first time. Among the 129 Fortune 500 Chinese firms, 48 are SOEs, and the top four Chinese SOEs in terms of annual revenue are SINOPEC Group (No. 2/500, 414.65 billion USD), China National Petroleum (No. 4, 392.98 billion USD), State Grid Corporation of China (No. 5, 387.1 billion USD), and China State Construction Engineering (No. 21, 181.5 billion USD). There are many locally managed SOEs, such as SAIC Group and FAW Group (supervised by provincial or municipal SASAC), in that list, as well.

2.2 The Birth of Dual innovation Systems

The main difference between the planned economy and the market economy is not whether it is a scientific plan, but whether resources are allocated by administrative power or by the independent choice of market players in the environment (Lewis, 2013).

From 1949 to 1978, SOEs held a dominant position or, in fact, were the only legitimate economic entities in China's economic system. The giant national projects and all resources were concentrated in state-owned enterprises, while POEs had not yet played a role in Chinese economic development. At this stage, although there was not a specific concept of innovation and creation, authorities still achieved the goal of stimulating technological progress by increasing the number of technical imports and providing research funding (Chen & Chen, 2010). Some industries, such as coal mining, construction, large machinery and agriculture, were developed rapidly during this period. However, most industries lacked market vitality. Therefore, during this period, the overall development of the national innovation system lagged behind significantly (Liu & White, 2001).

In 1978, POEs started to play a role in China’s innovation system. In the 1980s, the goal of the “institutional reform strategy” was to establish a modern enterprise system for SOEs, to push them to respond to market needs and to correct the agency problem by acknowledging the concept of property rights (Huang & Yu, 2013). Since then, private and non-public enterprises have been given a clear legal position as an important part of the Chinese economy. Figure Error! No text of specified style in document.-2 shows that the number of registered POEs has begun to grow, gaining an advantage in market competition. At the same time, many SOEs were allowed to transform into private enterprises. Some, however, bankrupt (Wu, 2013) because they were unable to attract the necessary talents and meet the needs of consumers in a competitive market (Shao, 2015).

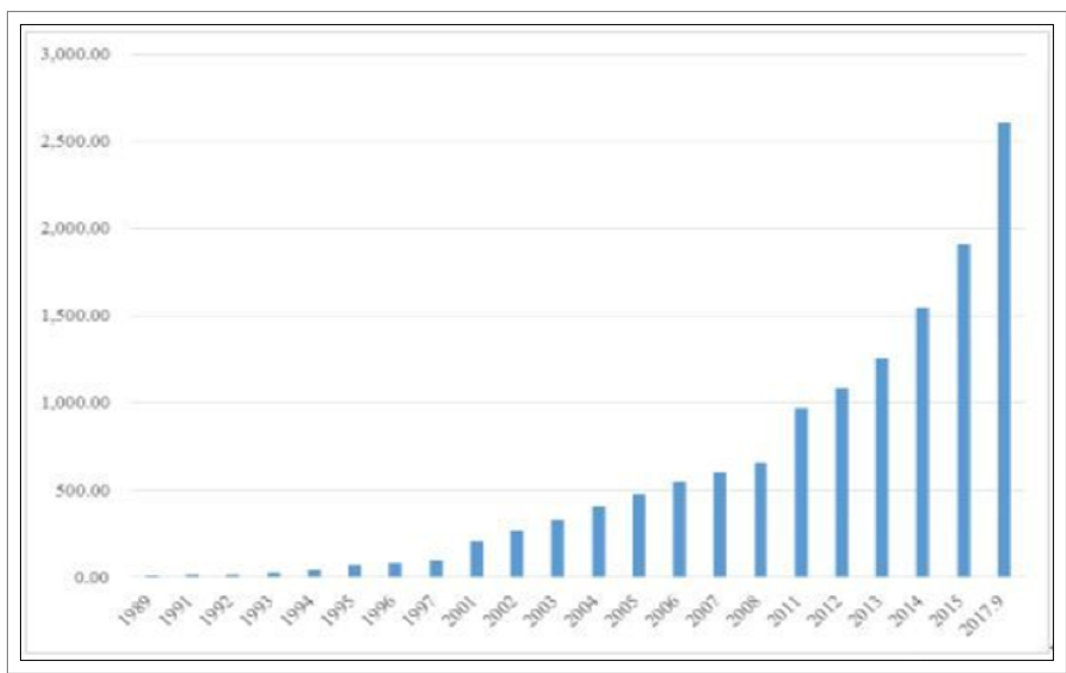


Figure Error! No text of specified style in document.-2. Number of POEs from 1989 to 2017.

Source: State Administration for Industry and Commerce of the People's Republic of China, SAIC

From 1998 to 2000, SOEs faced a big wave of major reform to deal with the nationwide inefficiency issue: i.e., keeping large SOEs while letting go of small SOEs (*Zuodafangxiao*). In line with this strategy, the number of state-owned enterprises decreased by 42%, and the number of laid-off workers reached more than 30 million. This situation gave birth to a large number of POEs. Nevertheless, the surviving SOEs became larger and larger, as many mergers and acquisitions followed—most of them in banking, utilities, telecommunications, construction, energy, etc., sectors that the government never tried to open to private enterprise. Two different but intertwined logics have been behind the reform of SOEs from the 1980s to the present: political or state logic—SOEs must take responsibility for national or political interests; and market logic—to ensure that SOEs operate with the efficiency of a private company.

In 2003, SASAC, a milestone in the development of SOEs, was established, allowing the central government to strengthen its monitoring of state assets as a political space. Following this logic, in 2004, the concept of the “Modern Enterprises Institution” became a new goal for SOEs to achieve. This concept required the governance of SOEs to be clear in terms of their ownership (to deal with the issue of principle-agency) and to have clear power and responsibility. It also required the separation of government and enterprise and scientific management. After that, many large SOEs or central SOEs began to be listed on the capital markets. Now, more than 70% of the assets of central SOEs belong to the listed companies.

However, in 2012, a new strategy of SOE governance was established. The central government worried that there was too much corruption in SOEs, and many top management teams had salaries as high as those of the boards of directors for listed companies. Thus, the central government installed government officials as CEOs and directors of the boards of SOEs. In a sense, the governance of SOEs is now more in line with the state logic than with the market logic. Yet, at the same time, the government also tried to make SOEs more innovative. For example, in order to design better incentives for employees, on August 17, 2018, SASAC passed the Guideline for SOEs’ Employee Stock Ownership Plan, which stated that the total employees’ stock ownership could not be more than 30% of total stock assets, and the chairman’s portion could not be more than 1%.

Meanwhile, since the late 1990s, POEs have entered a fast-growth stage. Many POEs emerged in industries such as real estate, steel, cement, chemicals, decorative materials, light industry, etc. According to the 2002 China Private Enterprise Survey Report, from 1991 to 2001, the annual growth rate in the number of POEs, registered capital and household capital reached 34.08%, 64.81% and 23.58%, respectively. The private sector's tax revenue grew at an average annual rate of 80.33%, making it the most dynamic and fastest-growing part of various economic sectors.

Meanwhile, the old laws and regulations that once hindered the development of POEs were largely abolished and revised; market access conditions were greatly relaxed; and the infrastructure industry was opened to POEs. In 2004, 2006 and 2009, respectively, the SME board, the New OTC Market and the Second-board Market were established. These new capital markets further expanded the financing channels of POEs (Howie, 2011). This series of major policies and events promoted the innovation and development in sectors of the private economy.

The different innovation models of SOEs and POEs can be traced back to their histories. The differences were obvious in the fundamental characteristics of the earliest stage of China’s transition from central planning to greater market coordination and decentralized decision-making (Broadman, 1995; Steinfeld, 1998; White & Liu, 1998).

From 1949 to the 1980s, SOEs were operated without R&D and sales divisions or other operational efficiency-based criteria for performance. SOEs were specialized “factories” whose activities and

interactions would be managed by the central government; even the relevant R&D departments were controlled by different levels of governmental applied research institutes outside of the SOEs (Liu & White, 2001).

In order to strengthen innovation capabilities at the firm level, in 1999, the government kicked off the transformation of governmental applied research institutes. These institutes were merged with large SOEs or directly transformed into independent SOEs. For example, the National Institute of Automobiles in Changchun was later merged with the First Automobile Group located in the same city. However, these reforms also made large SOEs, such as the Shanghai Baosteel Group, create their own new R&D divisions under their organizational structures.

Most of the 260 transformed central research institutes have survived. Some have become leading technology-based companies—for example, the Beijing General Institute for Nonferrous Metal became the Central Enterprise and Shanghai Electric Group Co. (Chen, 2012; Su, 2011; Zhou, 2016). Most of the transformed research institutes kept close connections with those manufacturing SOEs as their final users, such as Datong with China Telecommunication, China Mobile and China Unicom (Du, 2009).

POEs in China do not have a long history of R&D activities. Yet they have more capabilities to catch the windows of opportunity in both the market and technology. They also learn from the practices of foreign companies how to build their own innovation systems. Huawei is a good example of that. The company's innovation system owes a lot—such as the deployment of its famous IPD (Integrated Product Development)—to consulting help from IBM.

Innovations at POEs and SOEs are different in their nature and their focus on different sectors. First, POEs tend to focus on the lighting and household electrical appliance sectors as their main areas. Second, POEs, led by entrepreneurship, are good at taking advantage of new technologies, with a focus in the information revolution and the Internet economy. A number of private IT enterprises, such as Yahoo, Netease, Sohu, Sina, Baidu and Alibaba, were born due to the new windows of technological opportunity. After nearly 20 years of development, these companies have grown to lead the Chinese, and even the global, Internet economy. They have nurtured a number of world-class unicorns controlled by Alibaba. Leading Chinese POEs also have more quickly integrated into the globalization process and participated in more international competition than SOEs have. Both innovation inputs (in terms of R&D expenditures) and SOEs' and POEs' outputs (patents) can be seen in Figure Error! No text of specified style in document.-3 and Figure Error! No text of specified style in document.-4.

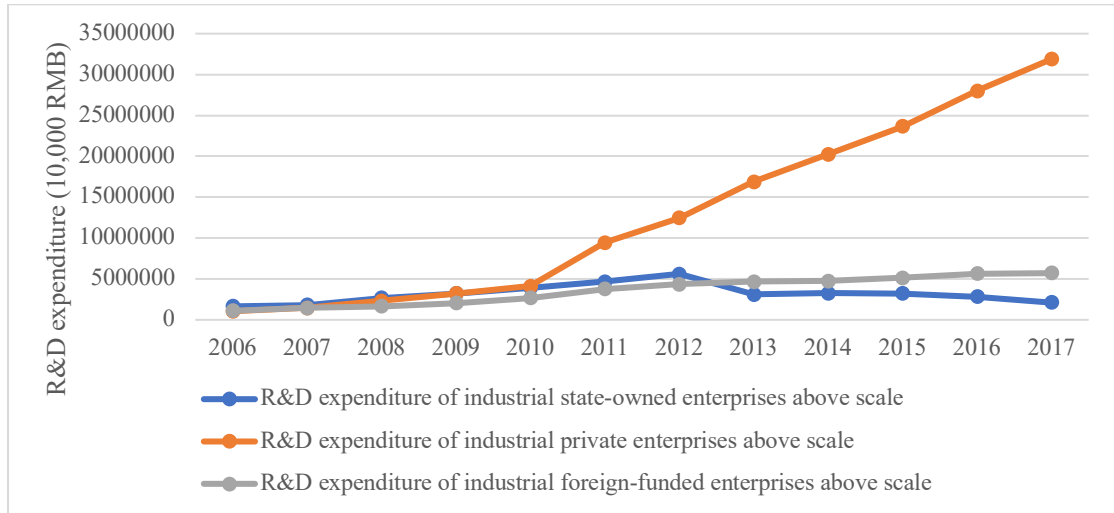


Figure Error! No text of specified style in document.-3. The R&D expenditures of SOEs, private enterprise and foreign firms.

Source : National Bureau of Statistics of China 2007-2018

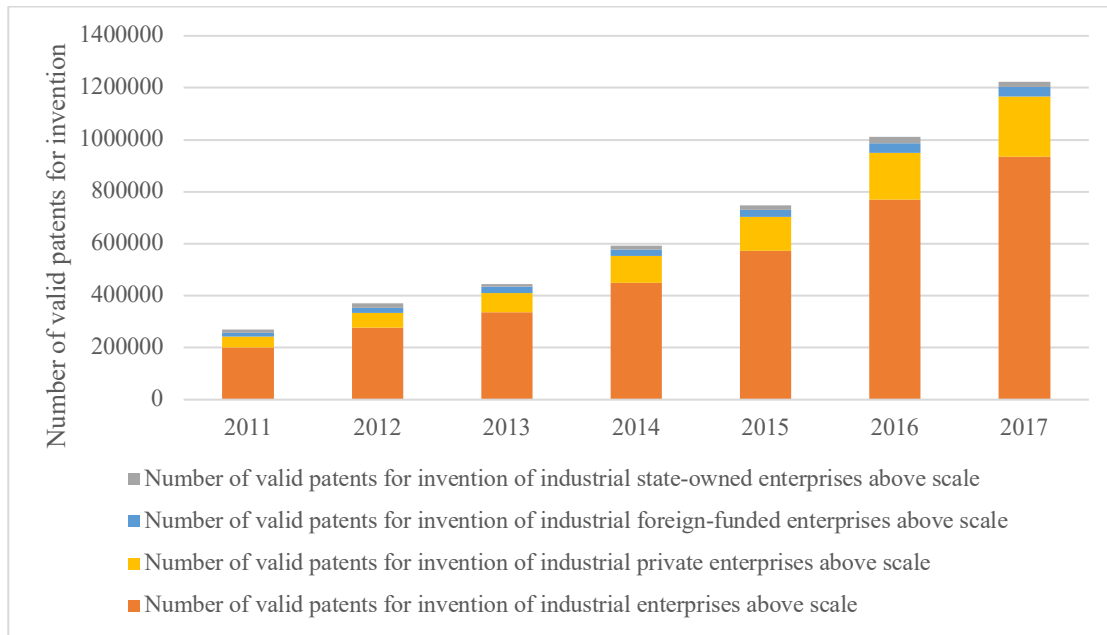


Figure Error! No text of specified style in document.-4. Patents of SOEs, POEs and foreign enterprises in China.

2.3 Different features of the two entities in the dual innovation system

We have shown that both SOEs and POEs have played an irreplaceable role in the Chinese dual innovation system, learning from each other and developing together (Liu, 2006). This section will examine their different innovation features in greater detail.

Different levels of innovation openness

Innovation in SOEs is somewhat more closed, while innovation of POEs is more open. Why? Most POEs are new to the industry and have to be more open in order to mobilize the necessary resources.

Thus, they make the effort to tap global resources and innovations from various enterprises and scientific research institutions and to gain knowledge from experts and scholars. (Chesbrough et al., 2006). By tapping the domestic market and exploring the “amphibious” strategy of the international market, POEs can enhance their global influence. For example, Huawei has over 70% of the market share that actually come from overseas. They have more breakthrough innovation in 5G by established world-class research and development laboratories.

SOEs are usually slow to go global, though they have more early experience in doing so that POEs have. Despite their earlier involvement in globalization, SOEs’ international presence has grown slowly. In the 1980s, SOEs realized the importance of technology through joint ventures with foreign companies. Table Error! No text of specified style in document.-1 shows some of the first overseas investment projects of SOEs from 1995 to 2000. For example, in January 1984, the Sino-US joint venture Beijing Jeep Automobile Co., Ltd. was established. In the 1990s, some home appliance manufacturers and motorcycle manufacturers began direct investment in Southeast Asia (Liu, 2018). However, these experiences have not allowed SOEs to participate more fully in the international market. The share of foreign direct investment stock of state-owned enterprises fell from 81% in 2006 to 50.4% in 2015. In 2016, the foreign direct investment of SOEs was US\$57.99 billion, while the foreign direct investment of POEs reached US\$123.24 billion.

Table Error! No text of specified style in document.-1. The first overseas investment projects of SOEs from 1995 to 2000.

SOEs	Year	Location	Content
Little Swan Company	1995	Malaysia	Building a home appliance factory
Hisense Group	1996	South Africa	Building a home appliance factory
Jincheng Corporation	1996	Colombia	Establishing a motorcycle factory
TCL Group	1996	Vietnam	Acquisition of DONACO (a color TV production enterprise)
CWGC (China Worldbest Group)	1997	Niger	Acquisition of a textile factory
<u>Konka Group</u>	1998	Indonesia	Building a home appliance factory
Chunlan Group	1999	Spain, Iran	Establishing a motorcycle factory
Gree Group	1999	Brazil	Building an electric appliance factory
Changhong Group	2000	Indonesia	Building a home appliance assembly factory

Different driving forces of innovation

The SOEs’ innovation is led more by the government, while POEs’ innovation is usually driven by dynamic market changes.

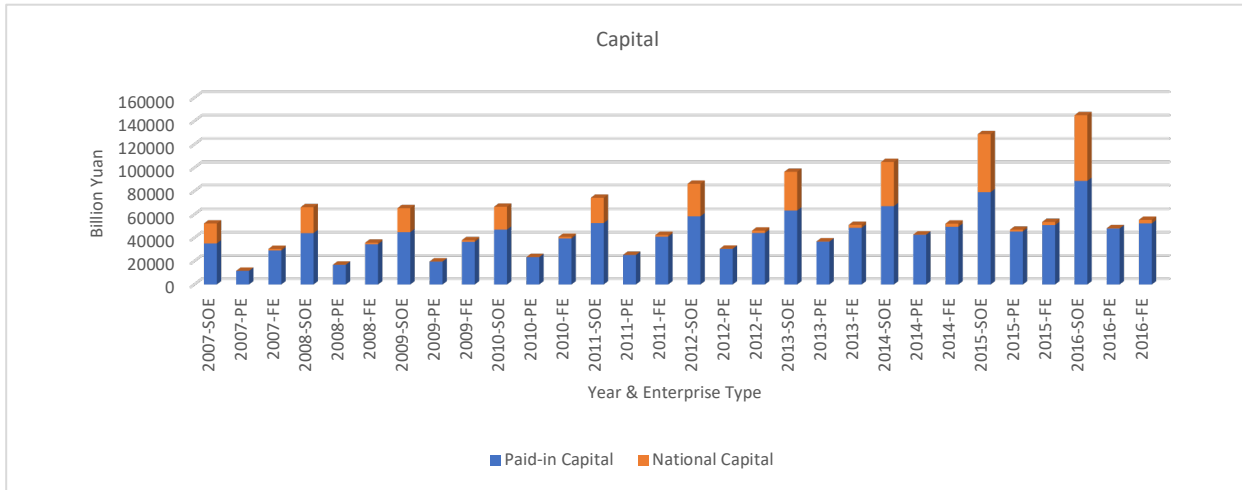
Most SOEs have a special mission: to maintain and increase the value of national assets. The Chief Executive Officer and senior managers of state-owned enterprises are selected and assigned by the government. If the business is run well, they will get promotions at the political level, rather than a direct financial reward (Eisenhardt, 1989). Due to heavy administrative limitations, SOE managers are not promoted due to the needs of business operations but, rather, due to their administrative qualifications and the SOEs' political missions. Thus, SOEs tend to adhere to government logic, while POEs are more concerned with market logic (Schotter & Andrew, 2008).

Innovation in POEs comes from market competition and entrepreneurship (Schumpeter, 1912). Haier's "Microenterprises" (MEs) and "Entrepreneurship at Scale" are typical examples of market-driven principles. Haier breaks from the traditional bureaucracy system and forms an open entrepreneurial ecosystem platform, creating countless self-employed, self-organizing and self-driven small and micro enterprises. This system enables everyone in the ecosystem to face the market and users and create value through independence (Hamel & Zanini, 2018). MEs determine resources and business arrangements according to their the goal of satisfying customers' needs. The salary distribution is leveraged by the value of the employee who maximizes the users' value. The drive to satisfy all the customers inspires more outstanding employees to invest in the future of the innovation ecosystem, which makes it possible for Haier's model to remain competitive in the long run (Pinchot & Pinchot, 1994).

Different sources of innovative resources

The resources for state-owned enterprises' innovation is usually the combination of internal existing resources and external monopolized resources that can be obtained under government protection, while POEs rely more on their own resources for innovation (David, 2000). Indeed, SOEs enjoy the inherent advantages of financing (Figure Error! No text of specified style in document.-5). For example, despite their high-level debt, SOEs can attain bank loans with a much lower interest rate, while POEs usually cannot enjoy such preferential policies.

Figure Error! No text of specified style in document.-5. Paid-in capital & national capital of different types of



enterprises.

Sources: authors' calculation based on National Statistics Yearbooks of China.

Nonetheless, the missions that SOEs carry out have become increasingly complicated and challenging, especially indigenous innovation. This presents a dilemma: on the one hand, compared to the POEs and foreign-invested enterprises (FIEs), SOEs lack incentives to increase productivity and profitability, as well as to meet all the sophisticated criteria in developing projects for the state; on the other hand, to execute the mission of indigenous innovation imposed by the state, SOEs usually mobilize financial resources and take risks to support the innovation in some national projects, often at a loss, which, in turn, may generate great financial returns on other projects (Naughton, 2018). It seems that this dilemma will not allow the indigenous innovation in SOEs to be sustainable—not to mention other challenging targets, such as gaining global competitiveness and leading global mega-projects.

In terms of talent resources, it is undeniable that POEs were weak at first. To improve this situation, many of them hired talented people or used the SOEs' "brain drain" strategy to learn the latest technologies. Many of China's successful POE entrepreneurs are former technology experts or engineers at SOEs. A good example is the founder of Huawei, Ren Zhefei, who used to be an engineer at an SOE. Another example is the founder of Lenovo, Liu Quenzhi, who was a researcher at an institute of the Chinese Academy of Sciences.

2.4 Interactions in the Dual Innovation System

The dual innovation system works in a parallel way with certain interactions in various industries. The relationship between the types of activities that organizations undertake may differ in terms of the industries involved, which means that SOEs and POEs have different contacts and rarely interact.

SOEs are strong and POEs are marginal in SOE-monopolized industries

In the fields of national defense, the military, energy, information and finance, all of which are industries strongly related to the national interest, SOEs have monopoly control (Shi & Zhong, 2018). These businesses have the following characteristics: large-scale investment; long returns on investment; universal service for the society; high social benefits; and low corporate yield. Therefore, the social responsibility of state-owned enterprises is to guarantee the development of the national economy. POEs are unable to enter these sectors, and, as a consequence, SOEs have limited interactions with POEs.

The infrastructure and utilities industries display three typical characteristics. First, the scale of investment is large; the payback period is long; and profitability is low. Second, they deal in public goods, so the social benefits are far greater than the private economic benefits. Third, they have the features of a monopoly, and if there is a private-sector operation, it is impossible to control POEs' access to high profits for self-interest (Cao et al., 2011).

Therefore, these industries are dominated by SOEs. However, they cannot be completely monopolized by SOEs. Thus, many POEs will be the suppliers for SOEs, and the two types of enterprises will work together to complete the industrial chain.

SOEs and POESs are complementary in competing industries

In some industries, such as automobiles, chemicals, and steel, SOEs and POEs may compete intensively with each other. These industries were originally dominated by SOEs, but modifications to China's economic system allowed POEs to enter, thus triggering competition. For example, in the steel industry, the majority of firms are SOEs, but one private enterprise, the Shagang Group, is also quite competitive. In the automobile industry, which SOEs used to control, private car manufacturers such as Geely and BYD have become competitive players in recent years.

POEs are strong and SOEs are marginal in emerging industries

Usually, POEs are more active in emerging industries. Industries that are highly uncertain require entrepreneurship and demand firms' fast responses to market needs. Under these circumstances, POEs are likely to emerge. Lenovo is a representative POE in the PC sector. Following decades of development, Lenovo became the PC leader in the world. In the telecommunications industry, the operators are all SOEs, but POEs such as Huawei have gained a strong foothold in hardware, including system equipment, switchers, and handset manufacturing. SOEs have almost no role in newly emerging markets such as E-commerce. Ali and Tencent are the new powerful POEs in these new sectors.

Similarly, in industries that meet consumers' daily needs, such as household electric appliances, food, garments, furniture, etc., SOEs originally had some control over the market. Over time, however, SOEs retreated, and POEs became the major market forces. As we can see, Chinese POEs such as Haier and Midea are latecomers, but now are global leaders.

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