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The internationalization process of Chinese research institutions since the reform and opening-up

Theory and practice

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Abstract

Purpose – The purpose of this paper is to systematically review the evolution, characteristics, motivations, entry patterns, organizational structure and effectiveness of the internationalization of Chinese research institutions in the past 40 years of reform and opening-up.

Design/methodology/approach – This paper describes the evolution and practice of Chinese research institutions "going out" by constructing a theoretical framework diagram and uses official statistics and existing research to explain the authors' points.

Findings – The research results show that the internationalization of research institutions has undergone four phases: sprout period, starting period, adjustment period and accelerating period. It shows a rapid growth of investment scale, diversification of investment entities, rich and varied forms, and transition to major countries along the "One Belt and One Road." Expanding the international market, tracking and acquiring technological frontiers, nurturing domestic R&D talents, and evading the risks of political, economic, cultural and scientific differences between home and host countries are the main motivations for Chinese research institutions to "go global." Multinational corporations have entered the host country with modes such as M&A, greenfield investment and joint R&D alliances in their own strengths and also presented a variety of organizational structures such as integrated R&D networks.

Originality/value – This paper systematically summarizes the internationalized experience model of research institutions with Chinese characteristics since the reform and opening-up. From the perspective of internationalization model transformation, policy integration and cooperation among emerging economies, it presents the opportunities and challenges faced by the research institutions in the process of internationalization and provides a theoretical basis for improving the internationalization ability of research institutions.

Keywords Chinese research institutions, Internationalization, Theory and practice,
40 years of reform and opening-up

Paper type Research paper

1. Introduction

In the past 40 years of reform and opening-up, the Chinese government has been constantly exploring and practicing the development strategy of promoting the internationalization of research institutions: From the strategy "march toward science" (1956) to the major

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assertion "innovation is the primary engine of development" (2015). China's foreign direct investment (FDI) has grown from more than $200m in 1984 to being the second largest foreign investor in the world. After 40 years of internationalization exploration, the internationalization of research institutions has achieved a series of results. For example, as of the end of 2016, there were 37,200 FDI enterprises in China, involving 24,400 domestic investors, distributed in 190 countries and regions around the world; 2014 was the first year wherein the Chinese enterprises' overseas investment growth rate was greater than the growth rate of FDI (Wang *et al.*, 2016). More than 1,500 Chinese companies in 88 countries and regions around the world had set up R&D institutions overseas, during 2010–2014. In 2016, China's FDI hit a record high, with a net value of $196.15bn, making it the second largest in the world.

The internationalization motivation of Chinese research institutions stems from the long-term challenges faced by Chinese local enterprises in the inadequacy of technology, and they urgently need to introduce advanced technologies from developed countries such as Europe and the USA to enhance their innovation capabilities and competitiveness. With the development of overseas markets and global knowledge production through information technology in the western developed countries in the 1970s, the establishment of overseas research institutions has become an important way for enterprises to carry out cross-border allocation of human resources, capital, knowledge and other R&D resources globally (Bolon, 1993). As the largest developing country, China has become an important investment destination for enterprises in developed countries. Therefore, Chinese enterprises have the opportunity to cooperate internationally with enterprises, universities and research institutions in other countries. For example, Weichai, in cooperation with the Austria Liszt Internal Combustion Engine and Test Equipment Company, has successfully developed products that meet Euro III and Euro IV standards, and its competitiveness has always been at the leading position.

After 40 years of exploration and practice, Chinese companies have experienced the process of catching up, imitating, learning and introducing technology and have accumulated rich experience in international management. However, China's unique national conditions will inevitably lead to the internationalized experience model of research institutions with Chinese characteristics. As the Chinese Government is constantly changing its management and service model, some Chinese companies have begun to actively export technologies overseas. For example, Tencent plans to set up artificial intelligence research center in Seattle; Techcode (Germany) incubator became the first Chinese incubator to receive German federal quality certification in 2017 (Chen and Li, 2017). Therefore, this paper will systematically review the process of internationalization evolution of Chinese research institutions in the 40 years of reform and opening-up, providing theoretical support for Chinese enterprises to continue to deepen the process of internationalization, enhance the effectiveness of internationalization and provide some references for the government to further optimize the institutional environment.

2. Literature review and theoretical framework

The internationalization of research institutions has always been valued by scholars. Both transaction cost theory and monopolistic advantage theory hold that R&D internationalization is the way for enterprises to achieve ownership and asset internalization, reduce the cost of transnational transfer of products and services, and gain a sustained competitive advantage, through the way of FDI, with the help of the location advantage and resource endowment of the host country (Dunning, 2013). For example, Chen *et al.* (2018) selected small- and medium-sized enterprise and growth enterprise market as samples and found that firms' actual controller's foreign residency right significantly enhances the overseas R&D development. Li and Yu (2016) took the listed companies in China's information technology industry from 2009 to 2014 as research objects

and found that R&D internationalization has a significant improvement effect on the innovation of multinational enterprises in China, and social resources carry out R&D internationalization and innovation for enterprises.

Institutional theory believes that due to the institutional differences between the host country and the home country, the research institutions face potential institutional risks in the process of internationalization. To this end, the integration into the host country's institutional environment helps enterprises to avoid the liability of foreignness and obtain legal identity in the new environment. Hsu *et al.* (2015) explored the relationship between R&D internationalization and co-innovation performance from the perspective of institutional theory with the longitudinal data of 202 Taiwanese high-tech enterprises from 2000 to 2010. The results show that in the initial stage of overseas research institutions, it is difficult to grasp the host country's institutional environment and fall into the risk of liability of foreignness. If they are not familiar with the foreign property rights protection system, they may face the risk of knowledge leakage.

From the perspective of embeddedness, the social network theory analyzes the relationship between the embedded relationship between the research institution and the local social network of the host country and the internationalization performance. By embedding the social network of the host country, overseas research institutions can easily access resources derived from network relationships, thereby enhancing the trust relationship between groups and speeding up information interaction and problem solving. Yoneyama (2013) took into consideration the factors of information, human and capital interaction between the base and the parent, and they found that the bases with weaker control by parent and stronger information linkage with parent demonstrated higher performance.

The knowledge-based view is the core theory to explain the internationalization of research institutions. This theory proposes that knowledge, especially tacit knowledge, is the core resource of enterprise heterogeneity, which is related to the core competitiveness and operational efficiency of enterprises. The internationalization of research institutions is an act of enterprises to expand the boundaries of knowledge flows. It cannot only support overseas research institutions to open up new markets through knowledge export, but also absorb, transfer, integrate and innovate host country knowledge through overseas R&D centers, and ultimately enhance innovation capabilities. Jaffe *et al.* (1993) study found that the establishment of overseas research institutions formed geographical proximity to the host country, and such geographical proximity could help organizations acquire tacit knowledge that is not easy to express and understand.

Organizational learning theory is inseparable from the knowledge-based view, and learning is one of the core tasks of the organization. The internationalization of research institutions is the process of learning from host companies, research institutes, universities and other organizations to acquire new knowledge and transferring overseas knowledge to the home company. Knowledge absorption ability is one of the important characteristics of organizational learning and also a core factor affecting the international performance of research institutions. Steinberg and Procher (2015) used 2,421 R&D-active German enterprises and examined how R&D offshoring implemented through captive offshoring and offshore outsourcing affects their innovation performance. They find that absorptive capacity amplifies the performance benefits of R&D offshoring in the case of both governance models.

Above knowable, related studies discussed additional motives such as leveraging the competitive advantages of nations (Pearson *et al.*, 1993), acquiring advanced technology (Kuemmerle, 1999), and skilled local talent (Florida, 1997), accessing complementary assets and the local market (Von Zedtwitz and Gassmann, 2002). However, as a developing country, China's internationalization of its research institutions is inevitably different from

that of developed countries. Therefore, to systematically elaborate the internationalization process of Chinese research institutions, we construct the theoretical framework, as shown in Figure 1, which will be discussed from the motivation, mode, organization and effect of internationalization of research institutions.

3. Evolution process

3.1 The overall process of the internationalization of Chinese research institutions

China's research institutions are gradually formed along with enterprises' overseas investment, so the development process of research institutions is consistent with the development process of enterprises' outbound strategy. Since the reform and opening-up, Chinese enterprises have generally gone through the sprout stage – starting stage – adjustment stage – acceleration stage (Zhao, 2012), as shown in Figure 2.

3.1.1 Sprout period (1979~1984). After the foundation of new China, the field of construction engineering first became an industrial field for Chinese enterprises to explore and practice "going out." With the increasingly active foreign trade, professional foreign trade enterprises and international economic and technological cooperation enterprises represented by China National Chemicals Import and Export Corporation began to gradually try to set up joint ventures or set up overseas representative offices (Zhao, 2012). And foreign trade exports have become the most important way for Chinese companies to "go global" during the exploration phase. After the Third Plenary Session of the Eleventh CPC Central Committee, China began to gradually make FDI. However, the development of enterprise investment abroad was slow. From 1979 to 1984, there were 113 enterprises in China, investing more than $200m abroad (Hu, 2011). Therefore, at the early stage of reform and opening-up, Chinese enterprises "going out" showed the characteristics of small-scale,

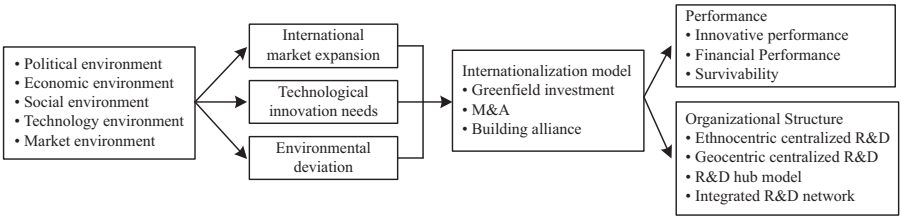


Figure 1. Theoretical framework of internationalization of Chinese research institutions

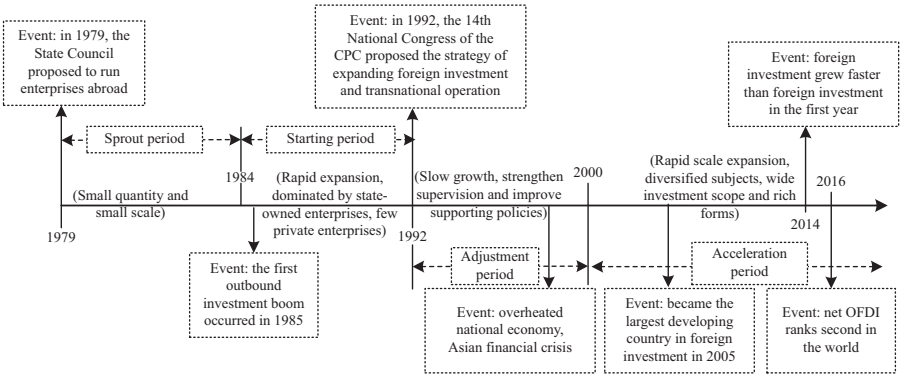


Figure 2. The evolution of China's research institutions going global

small quantity, narrow scope and state-owned enterprises as the main entities, and they were in the stage of trial and exploration.

3.1.2 Starting period (1985~1992). After initial exploration and practice, the policy of tying enterprises to overseas investment was gradually relaxed. In 1985, the first FDI climax appeared. The 14th National Congress of the Communist Party of China proposed the strategic ideology of expanding foreign investment and transnational operations and further stimulated enterprises to "go out." By the end of 1992, 4,117 enterprises participated in overseas investment through sole proprietorship, joint venture or cooperative production, and the investment area covered more than 120 countries (regions), and the investment amount reached 4bn Yuan. In the initial stage, the "going out" field of enterprises became increasingly diversified and gradually expanded to more than 20 industries such as transportation, processing and manufacturing, and resource development, etc. The types of enterprises are also increasing, and trust and investment companies, large and medium-sized enterprises, and scientific research institutions have joined the ranks of multinational operations. At this stage, the "going out" enterprises are still dominated by large- and medium-sized state-owned enterprises, and the private enterprises are relatively small, mainly subject to factors such as imperfect policy systems and economic development lag behind.

3.1.3 Adjustment period (1993~2000). The rapid development of the economy has caused prominent problems in the national economy such as imbalanced investment structure, soaring prices and overheated development. In order to maintain economic stability, the Chinese Government implemented a series of macro-control measures during 1993–1996. The policies concerning "going out" of enterprises mainly include the Regulations on the Administration of Overseas Enterprises, etc. These policies have tightened the approval of enterprises for overseas investment, and the emergence of the Asian financial crisis has further aggravated the decline in the scale of foreign investment. From 1993 to 2000, China's FDI showed a general downward trend and fell to the bottom in 2000. At this stage, the field of foreign investment involves the exploitation and production, processing and assembly of resources such as fishery, mining and forestry, and the major investors gradually shift from trading companies to large- and medium-sized production enterprises, and the proportion of overseas investment of production enterprises continues to increase (Zhao, 2012). This stage is also a systematic summary of China's foreign investment experience in the first 20 years. It strengthens overseas investment supervision by improving support and normative policies and proposes a new strategic policy for the development of overseas investment.

3.1.4 Acceleration period (after 2000). In 1997, after the outbreak of the Asian financial crisis, in order to speed up the pace of the "going out" and encourage firms of multiple ownerships with comparative advantages to invest abroad, China issued the "Opinions on Encouraging Enterprises to Carry out Overseas Processing and Assembly and Assembly Business." The government had taken several measures such as reducing approval procedures, simplifying procedures and decentralizing authority to reform the system of examination and approval, which had greatly promoted the coastal private enterprise to carry out the outside investment positively. In particular, in 2013, the Chinese Government proposed and actively promoted the construction of the "Belt and Road," which steadily carried out global cooperation on production capacity and improved the "going out" work system continuously, and the process of Chinese enterprises actively integrating into economic globalization was also accelerated. Figure 3 shows that after 2000, China's FDI showed a rapid growth trend. The average annual growth rate during 2002–2016 was 35.8 percent, which was 72.6 times that of 2002. The global ranking rose from 26th place in 2002 to 2nd place in the world. Although the current world economic growth is weak, the road to global FDI recovery is still rugged, and China's FDI has been in a strong growth trend.

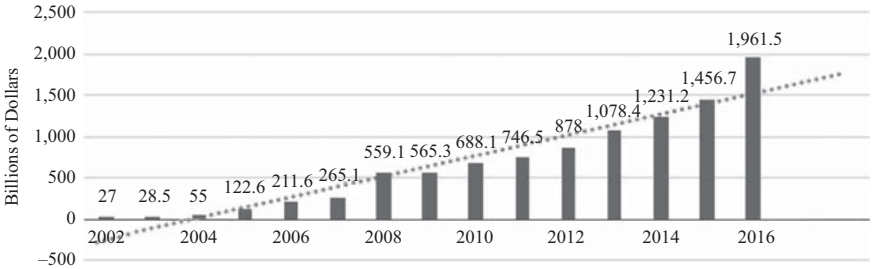
3.2 Main characteristics

3.2.1 Countries along the "Belt and Road" become key investment areas. At the end of 2016, China's stock of direct investment in the countries along the "Belt and Road" was $129.41bn, accounting for 9.5 percent of China's stock of FDI. The top 10 countries in stock are as follows: Singapore, Russia, Indonesia, Laos, Kazakhstan, Vietnam, United Arab Emirates, Pakistan, Myanmar and Thailand. In 2016, Chinese companies launched 115 M&A projects in the countries along the "Belt and Road," with M&A amounting to $6.64bn, accounting for 4.9 percent of total.

3.2.2 The investment field is expanding and the proportion of the industry is gradually changing. In 2003, China's FDI enterprises were distributed in 139 countries and regions around the world, accounting for 60 percent of the global countries (regions). The fields of foreign investment were mainly distributed in manufacturing, wholesale and retail, business services and mining, accounting for 92.6 percent of the net direct investment in that year, and the largest proportion of industry were manufacturing, wholesale and retail. By the end of 2016, investors in China were in over 80 percent of the world's countries (regions), and a total of 37,200 FDI companies were established in 190 countries and regions. All sectors of the national economy were covered. There were five industries with a volume of $10bn, of which the manufacturing, wholesale and retail, leasing and business services industries are still the most concentrated industries of overseas enterprises, with a cumulative total of more than 23,000, accounting for 62.7 percent of the total number of overseas enterprises.

3.2.3 Investment entities are gradually diversified, and private enterprises are increasingly active. In 2003, state-owned enterprises were the core subject of China's foreign investment, and the manufacturing, wholesale and retail industries were the major sectors of FDI. By the end of 2016, China's foreign direct investors reached 2.44m, and limited liability companies accounted for 43.2 percent, making it the most active group for Chinese foreign investment. Private enterprises accounted for 26.2 percent, ranking second; companies limited by shares accounted for 10.1 percent; state-owned enterprises accounted for 5.2 percent; foreign-invested enterprises accounted for 4.8 percent; Hong Kong, Macao and Taiwanese investment enterprises accounted for 3.2 percent; self-employed accounted for 2.4 percent, and shareholding cooperation enterprises accounted for 2 percent. Only 177 of the central enterprises and units accounted for 0.7 percent, and local enterprises and investors in various provinces and cities accounted for 99.3 percent. The manufacturing, wholesale and retail industries totaled 14,600, accounting for 59.9 percent of the total number of domestic investors.

3.2.4 The forms of investment are rich and diverse, M&A has become a core investment mode. In 2003, Asia accounted for more than half of China's FDI, and Hong Kong was the region with the highest concentration of FDI. In FDI, acquisitions account for 18 percent, profit reinvestment accounts for 35 percent, equity accounts for 14 percent, and other investments account for 33 percent. In 2016, the most active year in terms of Chinese



Source: 2016 Statistical Bulletin of China's Outward Foreign Direct Investment

Figure 3.
Trends in China's outward FDI flows from 2002 to 2016

company investment in abroad in M&A, there were total 765 M&A projects with a total transaction volume of $135.33bn, involving 74 countries (regions), of which $86.5bn was direct investment. It accounted for 63.9 percent of total M&A and 44.1 percent of China's total OFDI. Nearly 60 percent of the investment formed the equity of overseas enterprises, and the scale of debt instruments reached a historical extreme. The newly added equity investment was$114.13bn, accounting for 58.2 percent of the total flow in the year.

3.2.5 The scale of investment is growing rapidly, and the international position has risen significantly. The total foreign investment of Chinese enterprises increased from $200m in the early years of reform and opening-up to $196.15bn in 2016. In particular, in the past five years (2012–2016), the growth rate was more rapid, with an average annual growth rate of 22.3 percent. The total investment is twice the total foreign investment in the previous 33 years (1979–2011). The proportion of China's foreign investment in global foreign investment has been increasing continuously. From 2003 to 2016, external investment of China has successive 14 years maintained high speed growth, and in 2016, the flows of foreign direct investment were 72.6 times that of 2002. The global share of foreign investment increased from 0.5 percent (2002) to 13.5 percent (2016), which was breaking double digits for the first time. The position and role of China in the field of overseas direct investment is getting more important.

4. Motivation of internationalization

4.1 Technological innovation demands

The core motivation for research institutions to "go out" is to acquire technical resources (Cantwell and Hodson, 1991). Compared with the enterprises of developed countries in Europe and America, Chinese companies have long been subject to core technologies and cannot occupy the core of the industrial chain. They are often challenged by foreign governments and international giants. For example, in April 2018, ZTE was sanctioned by the US Government, prohibiting ZTE from purchasing parts, software and technology produced by American companies within seven years. ZTE was paralyzed by the lack of core technology for chip manufacturing. Lenovo Group was "kicked" out of the Hang Seng Index for the second time in May 2018. The core reason was that it had fatal dependence on US components. Therefore, the internationalization of Chinese research institutions includes two factors in the motivation of technological innovation demand: first, learning and keeping abreast of the latest technology, relying on overseas research institutions to transfer the latest industry technical information back to China. For example, in 2003, Hangzhou Jiali Technology established a R&D center in Germany. With the help of the R&D center, the company entered into a cooperation with Smith to obtain the production technology of the explosion-proof forklift. To keep pace with international advanced technology, Wanxiang Group set up Wanxiang USA Company and Wanxiang North American Technology Center in Chicago and Detroit, respectively, in 1994 to focus on new product development and design. The second is to employ technology talents from host countries and utilize its infrastructure to carry out technological innovations for home country products (Minina and Gammeltoft, 2012). For example, ZTE's original intention to set up a R&D organization in Sweden is to use the local technical advantages and resources in 3G communication technology, and then set up 15 research institutions in the USA, France and other places. After long-term study and tracking, it eventually grew into a world-competitive communication equipment manufacturer (Jing *et al.*, 2003), and its PCT international patent application ranked first in the world.

4.2 International market expansion

The development of the international market is conducive to enterprises to use the host country's superior resources at low cost and enhance the ability to control the international

scale and to operate internationally (Wang and Xie, 2017; Zhao, 2012). In order to meet the needs of the host country market, enterprises often transfer and transform S&T achievements through the construction of R&D centers in underdeveloped regions, develop products that meet local needs and carry out process innovations (Von Zedtwitz, 2005). For example, Huawei, ZTE and Haier have set up R&D centers in developed countries to develop localized technologies and products in order to meet the consumption habits and market characteristics of developed countries (Minina and Gammeltoft, 2012; Yang *et al.*, 2010). In addition, acquiring and cultivating innovative talents is also an important motivation for research institutions to "go out." For example, Jianghuai and Changan Automobile set up R&D centers in Italy, hiring local technical talents to participate in R&D; on the other hand, sending domestic talents to Italy to study R&D and management, etc., so as to achieve the goal of talents training (Minin and Zhang, 2010).

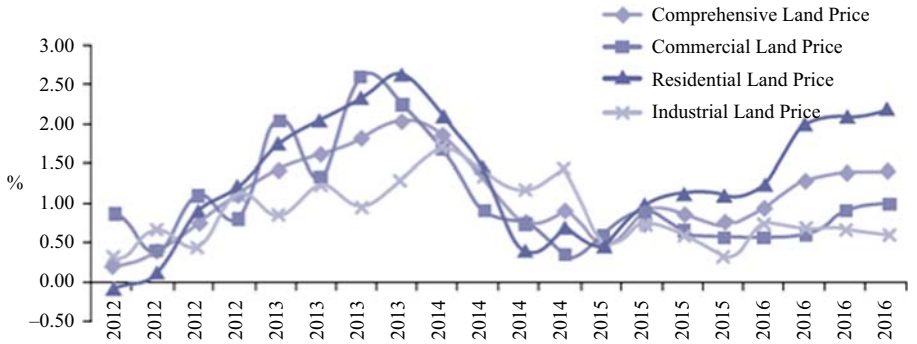
4.3 Environmental differences

The in-depth development of economic globalization and the advent of the Third Industrial Revolution will revolutionize the allocation of global technology and market elements (Chen and Li, 2017). A good environment for innovation, such as knowledge sharing, property rights protection and infrastructure, has become one of the important drivers for research institutions to go global (Håkanson and Nobel, 1993).

4.3.1 Domestic environment. Over the past 40 years of reform and opening-up, Chinese companies have been experiencing a process of increasing production costs year after year. The rapid development of economy has caused a huge consumption of resources along with a rapid increase in the price of land, labor and other factors.

The average wage of employed people in urban units in China has increased at an average annual growth rate of 10.6 percent in the past 10 years, significantly higher than that of Vietnam ($206), Malaysia ($538), Thailand ($438) and India ($136) in 2015 (WUIS, 2017). Thus, compared with the above-mentioned emerging economies, China's labor cost advantage has been lost. Some multinational companies began to seek development space in Southeast Asia. For example, in May 2018, Japan Olympus (Shenzhen) Industrial Co., Ltd was closed, and the factory moved to Southeast Asia; South Korea's Samsung (Shenzhen) abolished the Shenzhen factory and the production base was transferred to Vietnam; and in January 2017, Seagate closed the Suzhou Hard Disk Plant in China and announced that it will invest $470 million in Thailand in the next five years.

In addition, the rising land prices have also exerted tremendous pressure on the survival and development of enterprises. As shown in Figure 4, the prices of various types of land in



Source: China Land and Resources Bulletin 2016

Figure 4.
Changes in the monitoring of land price growth rate of major cities in China from 2012 to 2016

China are in an increasing trend. In 2005, the price of industrial land in China was 492 Yuan/m^2, and as of the end of 2016, the industrial land price was 782 Yuan/m^2, an increase of 58.94 percent. In 2016, the revenues of land sales in nine cities including Suzhou, Nanjing, Shanghai, Hangzhou, Tianjin, Hefei, Wuhan and Shenzhen exceeded 100bn Yuan. Labor, land and other factors affect business performance such as profitability, scale and financial strength, and business effects further influence the decision making of corporate R&D internationalization. At the same time, domestic R&D strength, openness and political connections will also affect the internationalization decision making of research institutions (Wang and Xie, 2017).

4.3.2 Foreign environment. The level of economic development, R&D resources, scientific and technological level, degree of external development and market size of the host country affect the internationalization of R&D. The higher the level of resource endowment, the greater the attraction to the enterprise. The patent protection, taxation and other policies of the host country also affect the international decision-making of enterprises. It is helpful to improve the international competitiveness by "going out" to realize the circumvention of trade barriers and circumventing some tariffs and restrictions.

For example, in August 2017, the Office of the US Trade Representative launched a 301 survey on China, focusing on legal policies or practices related to technology transfer, intellectual property and innovation. And in March 2018, Trump announced plans to impose 25 and 10 percent import tariffs on steel and aluminum, respectively. In June, the US old motorcycle manufacturer Harley–Davidson Motorcycles planned to transfer some motorcycle production to overseas. It can be seen that the establishment of an overseas research base directly at this time is easier for the host country to accept than the product export.

5. Model of internationalization

5.1 R&D alliance co-construction model

Since the 1980s, the rapid development of science and technology has prompted multinational corporations to achieve global resource allocation through co-construction of R&D alliances. In the twenty-first century, such R&D alliances have developed rapidly, and by 2007 there were 14,700 such alliances (Liu *et al.*, 2008). R&D alliances help reduce R&D costs and risks, accelerate the return of innovation investment and effectively avoid competition losses with competitors in non-core areas, and promote multinational companies to focus on core technology areas (Zhao, 2012). The co-construction of the R&D alliance model will help enterprises to seize the high point of innovation and enhance the core competitiveness of enterprises through the R&D network of partners. Enterprises that adopt the R&D alliance model for overseas cooperation often have certain technological advantages, scale and brand influence and have the ability to complement each other with other transnational multinational companies. For example, Weichai has always been in the leading position in the domestic market, but it is limited to diesel engine products that meet Euro I and Euro II standards, which have a big technical gap with the international advanced Euro III and Euro IV standards. For this reason, Weichai established a research and development alliance with Austria Liszt Internal Combustion Engine and Test Equipment Company (AVL) in 2003. Through such alliances, it successfully developed Euro III and Euro IV standard products, which prompted Weichai to maintain its leading position in the domestic market.

5.2 Greenfield investment model

The Greenfield investment model is the most common, direct and dominant mode for setting up overseas research institutions. More than 50 percent of the laboratories of the multinational companies in countries such as the Netherlands, the UK, and Germany are located in non-home countries (Zhao, 2012). For example, Siemens invested about 5bn euros in global R&D in 2017, and it established an independent innovation business unit, next47,

in 2016. The department next47 focuses on five major innovation areas that include artificial intelligence, autonomous machinery, distributed electrification and networked transportation. As of fiscal year 2016, there are more than 4,500 R&D personnel and engineers and 20 R&D centers in China alone.

Greenfield investment is often a technology-leading, brand-specific multinational company's overseas R&D capability expansion model. The Greenfield investment research institution has the characteristics of single investment, clear research and development direction and less involved in the distribution of interests and has relatively strong R&D autonomy and relatively small risks. Such overseas research institutions have similar culture and management style as multinational corporations. It is the main mode for Chinese enterprises to go abroad (Zhao and Liang, 2016). For example, Changan Automobile's research institutes established in Japan, Italy, the USA, as well as research institutes established by Hisense Group in Germany, Canada and other countries are greenfield investment models (Wang *et al.*, 2016). However, such a model requires a large number of R&D carriers to be constructed, and the cost is relatively high, such as equipment procurement.

5.3 M&A host country research institution model

M&A overseas research institutions can make full use of the advanced technology and resource network of the acquired parties and help to make up for the shortage of key technologies and form a strong overseas R&D capability in a short period of time (Zeng *et al.*, 2013), which has the characteristics of less investment, quick results, etc.

For example, in 2016, Qingdao Haier acquired US GE's home appliance business project for $5.58bn; Tencent acquired 84.3 percent stake in Finnish Supercell for $4.1 billion; Tianjin Tianhai Logistics for $6.01 billion acquired Ingram Micro International of the USA; China Yangtze River Three Gorges Group acquired the 30-year management rights project of Zhubia Hydropower Station and Ilya Hydropower Station for $3.77bn in Brazil (MOC *et al.*, 2018). However, there are many challenges in the M&A mode, such as resource integration and digestion, regional cultural differences, technology absorption, management capabilities and host country policy restrictions (Zhao, 2012).

6. Efficiency of internationalization

Since Chinese enterprises began to explore "going out" in 1979, the internationalization of Chinese enterprises has achieved remarkable results. By the end of 2017, 994 companies in national high-tech zones alone set up overseas R&D institutions. The high-tech industry represented by Lenovo, Huawei and ZTE, the home appliance industry represented by Haier and Hisense, the automobile industry represented by Changan Automobile, the dairy industry represented by Yili, and the incubator industry represented by Techcode have all established research institutions overseas, as shown in Table I.

7. Organizational structure

When the motivation of internationalization is different, the organizational structure of the research institution will also be different. Gassmann and Zedtwitz (1998) used 31 multinational companies from Germany, the USA, Japan, Switzerland and other countries as samples to analyze the main causes, obstacles and trends of the internationalization of research institutions. Then, organizational forms are divided into five typical categories in subsequent studies (Gassmann and Zedtwitz, 1999). Ethnocentric-centralized R&D: It focuses on R&D as the core organizational structure and R&D activities are concentrated in the home country to protect core technologies. Geocentric centralized R&D: Guided by global synergy, the market is tested through centralized R&D, and adaptive R&D is carried out.

Enterprise	Internationalization time (year)	Efficiency of internationalization
Lenovo	1992	Established the Silicon Valley Institute of the USA; timely access to the latest technology and information on computers
ZTE	1998	Established the US (New Jersey, San Diego, Silicon Valley) Research Center. By 2011, it has set up 15 R&D institutions in the USA, France, Sweden, South Korea and India and initially formed a global R&D network
Haier	1999	Found the Los Angeles R&D Center in the USA, responsible for in-depth study of the US market, timely and effectively collecting the needs of various US market segments, designing and developing innovative products that better meet customer needs
Huawei	1999	Set up a R&D center in Bangalore, India
	2000	Established a mathematics research institute in Russia to attract top Russian mathematicians to participate in Huawei's basic R&D; 16 research institutes have been established in the USA, Britain, Germany, Russia and other countries, and the R&D team localization rate of the research institute in Munich, Germany nearly 80 percent
Changan Automobile	2003	Set up the Italian R&D center in Turin, China's first overseas R&D institution for the automotive industry. Its main function is to acquire advanced technology from the host country, and improve product technology in the home country
Yili Group	2014	Established Yili European R&D Center with Wageningen University, the first overseas R&D center of China Dairy
Techcode	2017	Techcode (Germany) was awarded the "Federal Certification Innovation Center" by the German Federal Innovation and Technology Incubation Center (BVIZ), which became the first Chinese incubator to receive German federal quality certification
TCL	2018	Build a European R&D center in Poland, focusing on artificial intelligence technology for deep learning

Table I.
Typical cases and efficiency of internationalization of Chinese research institutions

R&D hub model: It strengthens the coordinating role of the home country R&D center, coordinates and supports the activities of overseas research institutions. Polycentric decentralized R&D: Guided by competition among independent R&D centers, R&D institutions are deployed globally, and R&D operations are carried out independently. Integrated R&D network: Taking the integration and coordination of global R&D institutions as the orientation, it forms a global R&D cooperation network and cooperates with each other to complete technological R&D and market development through their respective core R&D capabilities. In addition, Chiesa (1996) divided the overseas R&D organization model of multinational corporations into global heart, global specialization and global integration. Brockhoff (1998) divided the organizational model of multinational corporations' overseas research institutions into three types: central edge, multi-region competence center and global network organization.

The internationalization of Chinese research institutions started relatively late, but it also experienced the evolution from ethnocentric centralized to global network. In the initial stage, the "central edge type" is the main organizational model for the internationalization of Chinese research institutions, that is, the overseas research institutions are responsible for technical monitoring, searching and supporting headquarters R&D activities, and bringing the headquarters' innovative technology to the international market, whereas the process and product innovation activities are mainly completed by domestic headquarters research institutions (Jing *et al.*, 2003). During the development stage, the "star structure" has become the main organizational model and the status of overseas research institutions increased significantly, the functions have expanded to undertake the overseas transfer of headquarters technology, and the product and process innovations have been carried out for

overseas market conditions, but R&D resources are still limited by domestic headquarters. At the maturity stage, the "global collaborative innovation network" has become the core organizational model. The global market has become the core goal of R&D activities. Collaborative innovation activities between research institutions have become increasingly close, the central innovation center has disappeared, and coordination activities between headquarters and agencies are determined by the environment (Chen *et al.*, 2003). In recent years, with the deepening of Chinese research institutions, their organizational forms also presents a variety of types. For example, the overseas research institutions set up by Konka and ZTE are ethnocentric centralized R&D models, TCL overseas research institutions are typical R&D hub models, and Jindi overseas research institutions are typical geocentric centralized R&D models (Yang *et al.*, 2010). Huawei has gradually experienced the evolution of the dynamic organizational structure from "ethnocentric centralized R&D→geocentric centralized R&D→R&D hub" with the transformation of product development strategy (Liu *et al.*, 2010).

8. Conclusions

Through comparative analysis of data and theory, we have discovered a number of internationalized experience models of research institutions with Chinese characteristics. At the organizational structure level, China overseas research institutions are mainly responsible for technology tracking and monitoring, assisting domestic headquarters to carry out technology research and development, whereas western enterprises are mainly responsible for technology export. In terms of innovation effectiveness, the internationalization of research institutions has a positive impact on innovation performance, whereas R&D internationalization in developed countries has multiple conclusions, such as U-shaped and inverted U-shaped. At the level of internationalization mode, Chinese enterprises have a high degree of dependence on foreign technology, insufficient overseas talents and management experience. Therefore, more M&A methods are adopted, whereas western enterprises are more inclined to the Greenfield investment model, due to rich in management experience, low dependence on foreign technology and need technical protection. In terms of motivation, unlike the developed countries' technology export and overseas production support through the internationalization of research institutions, Chinese companies adhere to the concept of "technical catch-up," "technical learning" and "technology introduction" due to factors such as backward technology foundation. After nearly 40 years of "introduction-digestion-absorption-re-innovation," technology accumulation has been continuously enhanced and will gradually evolve from technological exploration to global technology leaders and finally form its own global innovation network system. Based on the evolution of Chinese research institutions, internationalization and combining existing research, this paper proposes that the following topics need to be further explored.

8.1 The transformation of internationalization mode

Due to the long-term dependence of Chinese companies on foreign technology, most Chinese companies, including Haier and Tencent, prefer to adopt the M&A model that has less investment and quicker returns to "go into" the host country. Therefore, the effect is good at the initial stage of internationalization. However, in recent years, the amount of M&A initiated by Chinese companies has become larger and larger, and the characteristics of brand acquisition and high-end technology have emerged, which makes the host government extremely sensitive. The government gradually increases its intervention in M&A projects. For example, in 2016, Fujian Grand Chip planned to acquire the German chip equipment manufacturer Aixtron for 670m euros, which was boycotted by the German Government, Unisplendour Corporation's acquisition of $3.7bn to acquire 15 percent of

Western Digital's shares, which was censored by the US Foreign Investment Committee. In 2016, the amount of transactions canceled by Chinese overseas mergers and acquisitions reached more than 75bn US dollars. To this end, in the future, we need to focus on exploring the path and method of Chinese enterprises to adopt other internationalization modes such as Greenfield investment and R&D alliance. Especially, with the rise of the internet economy and platform economy, the platform organization represented by Haier IDEA will become a new organizational model for Chinese companies to "go global," thus solving the dilemma of the current M&A model.

8.2 The integration of research institutions' internationalization support policies

The government's macroeconomic policies play an important role in steering research institutions to avoid blindly pursuing advanced technologies and entering non-business-related fields in the process of internationalization. However, the current policy still has a strong constraint on the internationalization of research institutions. In the future, it is necessary to focus on how to effectively integrate policies such as approval, finance, taxation and finance. The government must fundamentally change the path mechanism of policy services and support methods.

8.3 R&D internationalization cooperation among emerging economies

Most studies have focused on the internationalization of research institutions in developed countries, as well as the motivations of emerging economies to deploy overseas research institutions to developed countries. Of late years, with China's implementation of the "One Belt, One Road" strategy, China's investment in countries along the route is growing. By the end of 2016, China's direct investment stocks in the countries along the "Belt and Road" were $129.41bn, accounting for 9.5 percent of China's FDI stock. Chinese enterprises initiated 115 M&A projects in the countries along the "Belt and Road," with M&A amounting to $6.64bn, accounting for 4.9 percent of total M&A. It can be seen that the layout of investment and research institutions of Chinese enterprises in emerging economies is gradually increasing. So, what is the difference between setting up research institutions in emerging economies and those in developed countries? What are the characteristics of the research organization's internationalization motivation, organizational form, management style and effectiveness? Exploring the above issues will help to fully understand the internationalization of Chinese research institutions and supplement the existing internationalization theories.

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