
An Empirical Analysis on the Industry Differences of Overseas R&D Investment Layout of Chinese Manufacturing Listed Companies under the Background of Innovative Globalization

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Abstract

Based on the overseas R&D data of 340 Chinese Manufacturing Listed Companies from 1991 to 2016, this paper analyzes the industry differences of overseas R&D investment layout of Chinese Manufacturing Listed Companies, and focuses on analyzing the important factors affecting the industry differences of overseas R&D investment layout of Chinese Manufacturing Listed Companies. The study found that: the industry differences of overseas R&D investment layout of Chinese Manufacturing Listed Companies are affected by the degree of technology intensiveness, the industry distribution of foreign-funded R&D institutions in China, and the pre-emptive layout of overseas production organizations. Based on the research results, we provide useful suggestions for further promoting the vigorous development of Chinese manufacturing overseas R&D investment from the perspective of above four influencing factors.

Keywords

Chinese manufacturing, overseas R&D, investment layout, industry differences.

1. Introduction and Literature Review

Since entering the new century, knowledge and technology have become the core force for promoting economic and social development, and innovation has become the source of enterprise vitality. The ever-changing global competitive environment, the variability of the market and the complexity of innovation determine that companies cannot “close the door”. No country can rely solely on local forces for technological innovation, but also rely on innovative resources from overseas knowledge-intensive technology highlands. Especially for developing countries, due to the relatively backward technological level, they must actively participate in international competition and make full use of global technological resources to promote localized innovation. After more than 30 years of reform and opening up and economic development, the level of internationalization of Chinese enterprises has greatly increased, and the process of internationalization is no longer limited to production and distribution activities, but more and more covers research and development activities.

Generally speaking, the research on overseas R&D subjects is mostly a specific enterprise or a specific sub-sector of manufacturing, and does not grasp the overall manufacturing industry. In addition, the existing literature focuses on the motivation, location distribution, entry mode, and innovation performance of Chinese companies' overseas R&D. Few research focus on the characteristics of industry distribution differences in Chinese overseas R&D investment, and there is no empirical analysis of the influencing factors behind the characteristics of industry distribution differences. Based on the overseas R&D investment data of 340 Chinese manufacturing listed companies from 1991 to 2016, this paper comprehensively analyzes the distribution characteristics of the overseas R&D activities of Chinese manufacturing listed companies, and conducts empirical research on factors affecting the difference of industry distribution, so that to reveal overseas R&D

layout rules of Chinese manufacturing listed companies, and provide theory and policy basis for Chinese future promotion of overseas R&D investment activities.

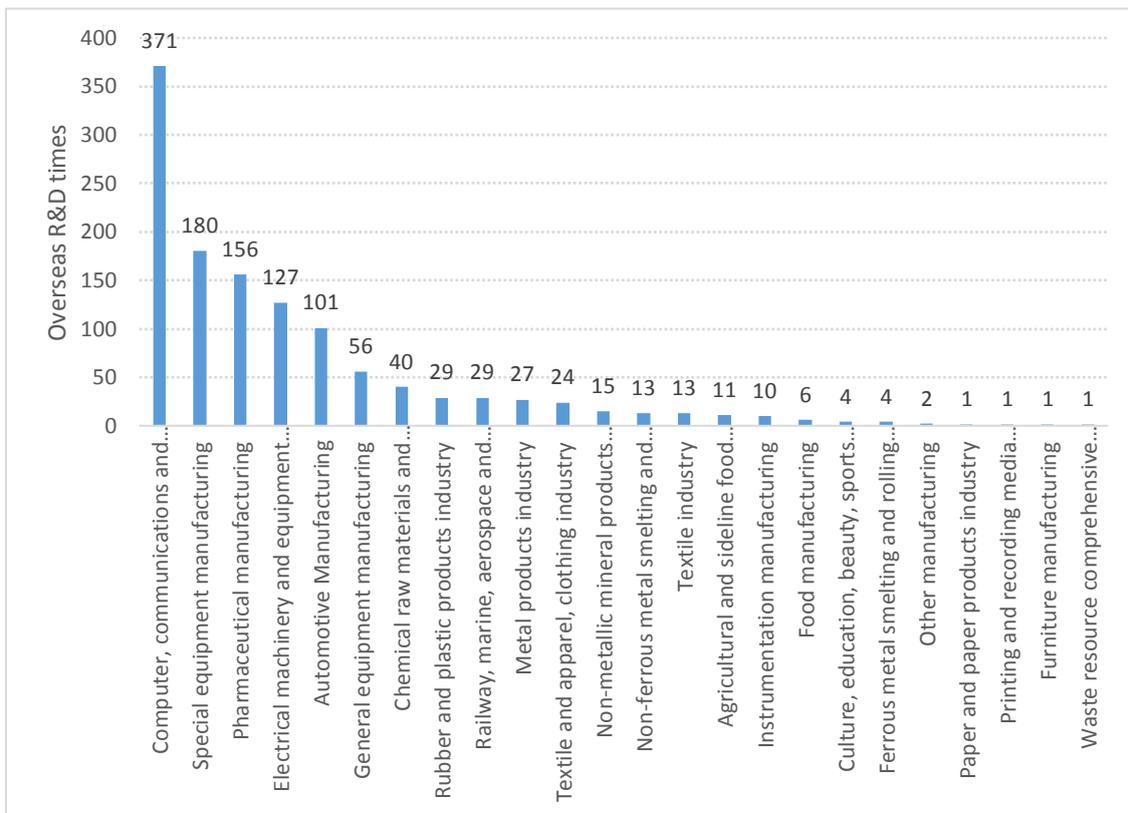


Figure 1: Industry distribution of overseas R&D activities of Chinese Manufacturing Listed Companies from 1991 to 2016

2. Differences of Overseas R&D Investment Layout of Chinese Manufacturing Listed Companies

2.1 Data source

This paper mainly uses manual methods to collect and sort out data related to overseas R&D activities of Chinese manufacturing listed companies. According to the China Securities Regulatory Commission's industry classification criteria for manufacturing (2013), the sample data was industrialized and eventually obtained 24 sub-sectors.

2.2 Industry distribution Differences of Overseas R&D Activities of Chinese Manufacturing Listed Companies

In 1991, the general equipment manufacturing industry took the lead in overseas R&D investment. After more than 20 years of development, overseas R&D activities covered almost all segments of the manufacturing industry. However, as can be seen from Figure 1, the industry distribution of overseas R&D activities of Chinese manufacturing listed companies is quite different. Among them, computer, communication and other electronic equipment manufacturing industry take the largest number of overseas R&D activities, totaling 371 times, accounting for 30.36% of the total overseas R&D activities, showing good technical pursuit; followed by special equipment manufacturing, the number of its overseas R&D activities is 180 times, accounting for 14.73%; pharmaceutical manufacturing industry also actively engaged in overseas technology learning and exploration, the number of its overseas R&D activities was 156 times, accounting for 12.77%; the number of overseas R&D activities of electrical machinery and equipment manufacturing industry was 137 times, accounting for 10.39 %; the number of overseas R&D activities of the automotive industry was

101times, accounting for 8.27%. The total number of overseas R&D activities in these five sub-sectors were totaled 935 times, accounting for 76.51% of the total overseas R&D activities. The high-tech industry has become the main body of overseas R&D activities of Chinese listed companies. However, there are only a handful of overseas R&D activities in the low-end manufacturing industries such as textiles and metal smelting.

The development of overseas R&D investment shows a certain industry imbalance, indicating that there are always differences in the overseas technology seeking and development of various industries of Chinese manufacturing industry. The difference in overseas R&D distribution has further widened the industry development gap. This paper analyzes the important factors affecting the industry difference of Chinese manufacturing overseas R&D activities, and explores the potential driving force of Chinese manufacturing overseas R&D investment, thus promoting the healthy and rapid development of Chinese overseas R&D investment. Innovation. This is the focus of this paper and the innovation of this article.

3. Analysis on the factors affecting the distribution characteristics of overseas R&D activities of Chinese manufacturing industry listed companies.

3.1 The different technical intensities of various industries determine the industry layout differences of overseas R&D activities of Chinese manufacturing industry listed companies.

While all products and services reflect a certain amount of knowledge, the degree of reliance on knowledge and technology elements varies significantly across industries. According to the OECD industry R&D content classification and the actual development of Chinese manufacturing industry, we divide 24 sub-sectors are into three categories: high-tech manufacturing industry, medium-tech manufacturing industry and low-tech manufacturing industry. It can be seen from Table 1 that Chinese overseas R&D activities are concentrated in five major industries: computer, communications and other electronic equipment manufacturing, special equipment manufacturing, pharmaceutical manufacturing, electrical machinery and equipment manufacturing, and automobile manufacturing, this five industries belongs to high-tech manufacturing industry. Medium and low-tech manufacturing fields are often labor-intensive industries, technology is not a decisive factor in development, it often relies on low-cost to achieve scale operations and thus forms a cost-based advantage, therefore, labor costs and market are important considerations for the development of these industries. High-tech manufacturing industry is often technology-intensive industry with characteristics of fast technology updates, short product life cycles, and a large percentage of price declines, advanced scientific knowledge and outstanding R&D talent supply and first-rate scientific infrastructure and information infrastructure are key element to promote its development. Therefore, as for high-tech manufacturing, R&D is an important strategic activity to establish its competitive advantage.

Due to the unbalanced distribution of science and technological knowledge in the world, science and technology progress has grown unevenly around the world. Compared with the current innovative advanced economies, the knowledge base of high-tech industries of emerging economies tends to be narrower and shallower. High-end technology and high-end talent supply still have a big gap with the Western industrial powers(Snehal, Marcus and Ram, 2012). The partial hidden nature of technical knowledge and the strong monopoly of high-tech manufacturing make it difficult for companies to obtain high-end technology only through simple technical imitation and learning to leading companies, and the relevant technical knowledge of some innovative activities is “sticky”, these technologies are located within a specific area (such as computer technology in Silicon Valley, North Carolina, and medical technology in North Carolina). The marginal cost of transmitting these tacit knowledge increases with distance, and cultural and institutional differences can also affect quality of knowledge of transmission (Narula and Zanfei, 2005; Boschma et al., 2014), the path dependence and cyclical cumulative causal effects of self-continuation of R&D lead to clusters of innovation

activities, thus, in order to benefit from the external economic effects and knowledge spillover effects from the concentration of production and innovation activities in specific regional or national clusters, high-tech manufacturing can only enhance their knowledge base by focusing their overseas R&D institutions mainly on knowledge-related highlands and talented rich areas worldwide.

Table 1 Classification of manufacturing technology content

Category	Sub-sector
High-tech manufacturing	Computer, communications and other electronic equipment manufacturing, Special equipment manufacturing, Pharmaceutical manufacturing, Electrical machinery and equipment manufacturing, Automotive Manufacturing, General equipment manufacturing, Chemical raw materials and chemical manufacturing, Railway, marine, aerospace and other transportation equipment manufacturing, Instrumentation manufacturing.
middle-tech manufacturing	Rubber and plastic products industry, Metal products industry, Non-metallic mineral products industry, Non-ferrous metal smelting and rolling processing industry, Waste resource comprehensive utilization industry.
low-tech manufacturing	Textile and apparel, clothing industry, Textile industry, Agricultural and sideline food processing industry, Culture, education, beauty, sports and entertainment products manufacturing, Food manufacturing, Paper and paper products industry, Printing and recording media reproduction, Furniture manufacturing, Other manufacturing.

3.2 The difference in the industry distribution of foreign-invested R&D institutions in China affects the industry layout of Chinese manufacturing overseas R&D activities, and the layout of the them tends to be consistent.

The R&D institutions established by foreign capital in China has a dual impact on Chinese companies: on the one hand, in the manufacturing industry, most of the R&D institutions in China are highly specialized and science-based producers (LeBas and Sierra, 2002), although the motivation for these foreign-invested R&D institutions in China is not to provide knowledge and technology for locality, due to the special nature of technology R&D activities, the search and collation of information required for R&D and the integration of knowledge in various fields have led to significant externalization and marketization trends, thus promote the transfer and diffusion of advanced technology and innovative experience, objectively improved the technical level of the industry, making Chinese products in this industry more competitive in the global market, on the other hand, in order to maintain competitive advantage, foreign capital often monopolize key core technology when they transfer technology to host country, and transfer technologies that are already in maturity, recession, or are quickly eliminated. Under the intensification of foreign advanced technology products, the intensity of competition in the domestic market has intensified, and domestic enterprises are facing market dilemma. Therefore, The R&D institutions established by foreign capital in China has formed a dual monopoly on the domestic market and technology, occupying the scarce people's innovative resources in China. The dual impact of setting up R&D institutions by foreign capital in China has an important impact on Chinese manufacturing R&D activities: First, foreign R&D activities in China promote technological development in the industry, which makes Chinese companies have comparative technological advantages compared to other developing countries. In the case of foreign enterprises occupying an absolute competitive advantage in domestic market, based on the competitive effects and demonstration effects brought about by the R&D of foreign companies, enterprises have begun to turn to develop new markets for survival and development. Second, multinational corporations' monopoly on technology and the plundering of talents have made enterprises realized that only through the simple imitation of the technology spillovers of international leading companies is limited for enterprises' innovation (Shou Keyan, 2015), and began to try to locate their R&D institution in developed countries to solve technical bottlenecks, and enhance

technological innovation to narrow the technological gap with foreign companies to achieve overtaking.

According to Ye Qing's data on 853 R&D centers engaged in manufacturing in China, which are used in the *research on the industry structure and spatial distribution of foreign-funded R&D centers in China*, we obtain the comparative data of industry distribution of foreign-funded R&D centers in China and Chinese overseas R&D center, as shown in Table 2. We found that the R&D institutions established by foreign capital in China are concentrated in the technology intensive industry: computer, communication and other electronic equipment manufacturing, pharmaceutical manufacturing, electrical machinery and equipment manufacturing, transportation equipment manufacturing. In the field of computers, communications and other electronic equipment manufacturing, the number of multinational R&D centers in China is much higher than that of other industries, accounting for almost one-third of the total foreign R&D institutions. Its distribution is basically consistent with the distribution of Chinese manufacturing overseas R&D activities. Although the data on the number of R&D centers of multinational companies in China is only as of 2007, according to Zhang Yu's research conclusion on analyzing industry distribution of R&D institutions setting by multinational companies in 2014 by using data of 897 R&D institutions established by multinational companies in China from 1999 to 2011, we find that the R&D investment of multinational companies in China is still mainly concentrated in the high-tech industries such as electronic and electrical, biomedicine, automobile, chemical and chemical, and technology-intensive high-tech industries.

Table 2 Comparison of the industry distribution of foreign-funded R&D centers in China and the setting of overseas R&D centers of Chinese enterprises

industry	Number of multinational companies R&D centers in	Number of overseas R&D centers of
Computer, communications and other electronic equipment manufacturing	284	371
Pharmaceutical manufacturing	146	156
Electrical machinery and equipment manufacturing	98	127
Special equipment manufacturing	77	180
Automotive Manufacturing	62	101
Chemical raw materials and chemical manufacturing	58	40
Instrumentation and culture, office machinery manufacturing	28	10
other	100	210

Source: Ye Qing. *research on the industry structure and spatial distribution of foreign-funded R&D centers in China*, 2009.

3.3 The predecessor layout of overseas producing institutions of Chinese manufacturing listed companies leads the overseas layout of its R&D institutions, and the industry distribution of the two types of institutions is gradually converge.

According to the original product cycle theory model, the overall strategy of overseas R&D of enterprises is carried out with the outward shift of production branches. Seropio pointed out in "Industrial Globalization: Testing of Foreign Direct Investment in the United States" that companies conduct overseas R&D to provide supporting assets, which are essential to support the overseas

production and operation of enterprises. Along with the overseas operation and production transfer of enterprises, in order to maintain competitiveness in the international market, enterprises often need to conduct product-adaptive R&D based on the host country market, and product design and process may change in different countries and regions. In the 1990s, the establishment of R&D institutions of multinational corporations in China also injected new vitality into the R&D of Chinese enterprises, which made Chinese enterprises realize that their R&D were separated from production and market. After that, they paid more attention to Combing R&D with market.the greater the proportion of production institutions of the industry in the whole industry, the greater the proportion of overseas R&D institutions of the industry in the whole industry, that is, the more production institutions in the industry, the more the number of overseas R&D institutions in the industry. Although the proportion of production institutions of the pharmaceutical manufacturing industry is not consistent with the proportion of R&D institutions, this is also due to the strong discipline and the long development cycle of the pharmaceutical manufacturing industry. China is still relatively backward in the highly scientifically intensive areas such as new drug development, through simple imitation learning or pure technology spillovers, it is impossible to obtain production technology that is established and developed in foreign markets. Therefore, at this stage, the establishment of Chinese pharmaceutical manufacturing R&D institutions is affected by production institutions, but compared to other industries, it is more for the purpose of exploring technology abroad to reduce the gap to promote the development of China's pharmaceutical manufacturing industry.

According to the classification of R&D internationalization motivation by Zhao Xianjin and Liang Lu (2016), we think that there are two basic motivations for overseas R&D of manufacturing listed companies: The first is technical exploration, that is, the enterprise acquires and absorbs foreign knowledge and technology by setting up an independent R&D center overseas, aiming at enhancing R&D capability of the enterprise, which is an innovative overseas R&D; the second is technology development, that is, the establishment of overseas R&D center by enterprises is mainly to support the production and operation activities of the production or sales-type overseas subsidiaries, and to implement product R&D and technological transformation for the purpose of adapting to the host country market. It is an adaptive overseas R&D. The realistic factor of the R&D industry distribution is mainly due to the promotion of the "One Belt, One Road" strategy and the support for the emerging industries by government, which have brought opportunities to the development of these industries, and greatly promote the above-mentioned industries to go out and participate in the international market competition. While China rely its low cost advantage to enter the international market, the developed country multinational giants have already formed a foothold in the global market, in order to survive in the cracks and occupy a place in the fierce international market, it is necessary to construct a complete overseas operation system of sales-production-R&D, and carry out adaptive R&D based on the host country's situation to improve the resilience and product competitiveness.

4. Conclusions and suggestions

Through the investigation and analysis of the industry distribution characteristics of the overseas R&D activities of Chinese manufacturing listed companies, we find there a great industry distribution differences of overseas R&D of listed companies in Chinese manufacturing listed companies, that is, overseas R&D activities are mainly distributed in high-tech manufacturing industries such as computer, communication and other electronic equipment manufacturing industries, equipment manufacturing, pharmaceutical manufacturing, electrical machinery and equipment manufacturing, and automobile manufacturing, but in medium and low-tech manufacturing industries such as metal products industry, non-metallic mineral products industry, textile and garment, apparel industry, textile industry, agricultural and sideline food processing industry, there are relatively few overseas R&D activities.

Through the analysis of the factors affecting the distribution of the industry, we find that the industry distribution of overseas R&D activities of Chinese manufacturing listed companies are affected by the degree of technology intensiveness, the industry distribution of foreign-funded R&D institutions

in China, and the pre-emptive layout of overseas production organizations. The need for industry technology seeking is the endogenous driving force for overseas R&D of enterprises. The market technology dual monopoly caused by R&D in China by foreign companies and the need to support the overseas production enterprises are the exogenous driving force for overseas R&D of enterprises. Based on the above analysis, this paper proposes the following suggestions for Chinese manufacturing listed companies to further promote the development of overseas R&D activities :

First, the degree of technology intensiveness varies from industry to industry. Enterprises in different industries should determine the R&D path based on the specific development of their own and country. For industries that rely on low-cost advantages, especially for Chinese low-tech manufacturing industry, such as textile and garment industry, the development path is not created by China. Its innovation strategy is not mainly technological innovation. These industries should develop along the path of production manufacturing——advanced manufacturing and international manufacturing —— optimizing manufacturing, and at the same time, improve the wages of skilled workers to solve the bottleneck of the "big country craftsman". For industries that rely on advantages of rapid technology and product imitation, it is not enough to “run and run” and “learn to run”. It is necessary to increase investment in overseas R&D, establish independent overseas R&D institutions, and effectively integrate existing manufacturing capabilities and marketing capabilities, so hat to further cultivate knowledge advantages that are unique and difficult to imitate, more rooted in the enterprises, so as to be in a favorable position in the global knowledge production network.

Second, “bringing in” and “going out” are equally important, making full use of the spillover effects of foreign R&D investment in China. On the one hand, the main policy tools of the central government and other local governments should promote joint technology development between Chinese enterprises and multinational corporations, and guide multinational corporations to carry out more technological innovations in China in some major contracts and projects controlled by the government, and encourage Chinese companies to improve their product development capabilities through technical alliances with other multinational companies and other technologies. For example, government guidance has played a very good role in the development of Chinese high-speed rail, aviation and avionics. On the other hand, the identification and utilization of external knowledge resources depends to some extent on the original knowledge base. Therefore, Chinese enterprises should increase investment in R&D, actively cooperate with domestic universities and scientific research institutions, improve their technological accumulation and independent innovation capabilities, and provide good basis for better benefit from multinational companies' R&D technology spillovers in China.

Third, developmental R&D and exploratory R&D go hand in hand. In order to realize the transition from “follow-up” to “companion” or even “leader”, companies must do a good job of balancing technology development and technology-exploration R&D, and pay attention to meeting the needs of existing markets, and also maintain innovative, adventurous and forward-looking to cope with the dynamic environment (Wei et al., 2014) , then gradually strengthen technical exploration, and under the good technical development plan to actively set up basic R&D centers in developed countries to realize collaborative innovation in technology development and technology exploration, and use industrial agglomeration advantages and technology spillover effects to engage in high-end cutting-edge technology research work, and carry out cross-border diffusion and market application of innovation results to achieve an internationalized layout of enterprise R&D systems.

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