

## Internationalized R&D Network of Chinese Enterprises: Late-development Constraints and Network Relations

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### Abstract

**From the perspective of enterprises in late-developing economies, this paper uses grounded theory to explore the relationship model and its constraints of China's enterprises' international R&D network. The research results show that enterprise capability endowment, network organization structure, network relationship interaction and latecomer characteristics jointly affect the construction and management of China's enterprise internationalization research and development network. Among them, the interaction of network relations can determine the organizational structure of the network to some extent. A good network relation can enhance the capability endowment of enterprises, reduce the possibility of Chinese enterprises suffering from technical barriers and policy barriers, and weaken the backward disadvantage of Chinese enterprises in constructing and managing internationalized research and development networks. Therefore, relationship management is a key step in the management of China's international R&D network, which is of great significance to the management of China's enterprises' international R&D network.**

### Keywords

**Internationalized R&D Network; Late-development Constraints; Network Relations.**

### 1. Introduction

Since the 1990s, multinational enterprises have gradually become an important channel for enterprises to acquire technological resources, develop innovative advantages and speed up the process of internationalization in order to break through the existing knowledge boundary of their home countries and absorb talents, technologies and other resources to carry out research and development of new technologies and new products in a global scope. Issues such as the motivation, evolution path, organization mode, location selection and performance results of internationalization of research and development have become the focus of attention of scholars from all walks of life [1]. As a latecomer economy enterprise with international R&D, one of the motivations for Chinese enterprises to carry out international R&D is to identify and acquire overseas advanced technological knowledge [2]. Different from the explosive growth of R&D internationalization of multinational enterprises in developed countries, China should not carry out rapid geographical expansion under the conditions of basic resources, technological capability endowment and institutional weaknesses, otherwise the increase of exchange costs will weaken the reverse knowledge spillover effect [3]. By means of technology introduction and imitation, and by means of internationalization as a "springboard", we can gradually catch up with and surpass technology [4]. In this process, we will overcome the reverse influence of geographical isolation mechanism on knowledge spillover effect [5], escape from the saturated Chinese market and the fierce competitive environment of low prices, and realize the expansion of knowledge channels and the enhancement of independent innovation capability. In the 1990s, the motivation for international R&D turned into a large demand for R&D personnel [6]. The rapidly changing overseas market and the diversity of technology/knowledge stock have made it difficult to support overseas services only by inexperienced research and development personnel. Therefore, a large number of professional research and development

personnel and management personnel are needed. The introduction of foreign talents and the coordination of network relations will help China's international research and development [7].

With the deepening of the internationalization process, enterprises are more inclined to build an internationalized research and development network with more organizational advantages, so as to form complementary resources with the members of the network to make up for the shortage of their own enterprises in order to adapt to overseas markets [8]. At the same time, enterprises use the asymmetry of information to distribute research and development activities in the world, build a more complex division of labor and cooperation network, and reorganize and integrate the resources in the network into their own core competitiveness [9]. However, in this process, China's international research and development has not achieved the expected performance. An important endogenous reason is that China's enterprises are still stuck in the "catch-up bottleneck" of embedding difficulties and low-end locking. The lack of experience in the degree of network openness leads to the "open" paradox and the "dancing with wolves" paradox [11]. Under this unstable foundation, as a latecomer of emerging economies, China is still suffering from severe external attacks from policy barriers and technical barriers. Therefore, building an international research and development network with reasonable structure and stable foundation is the key measure for Chinese enterprises to enhance their research and development capabilities and occupy the international market.

Based on this, this paper, from the perspective of a latecomer economy and taking China's international research and development enterprises as the object, attempts to explore the key factors that affect the construction and management of China's international research and development network, and on this basis, provides corresponding policy recommendations for the construction and management of China's international research and development network.

## 2. Method selection

### 2.1 Research ideas

In this paper, qualitative research methods of grounded theory are used to analyze the data. Relevant documents of international R&D are taken as the initial material, and theories are summarized step by step to analyze the relationship model and constraints of China's enterprises' international R&D network from top to bottom. Existing literature databases provide sufficient research data for the research, while grounded theory is applicable to data-oriented framework reconstruction [12], which ensures the feasibility and integrity of the research.

### 2.2 Literature collection

(1) Literature sources and retrieval conditions: Compared with other Chinese databases, CNKI database has wider coverage, stable and reliable sources of literature, and higher quality of literature. Therefore, CNKI database is selected in this study, and the retrieval type is selected as journal articles, and the journal sources are set as core and above journals.

(2) literature retrieval: in this study, 75 retrieval results were obtained by setting the subject word or keyword as "international research and development" in CNKI database; Set the subject word or keyword as "transnational research and development" to obtain 268 search results; A total of 343 search results. At the same time, in order to ensure the reliability of the study, two assistant personnel were invited to carry out collaborative literature retrieval. The retrieval results for the three times were 343. However, there are documents overlapping in the two results. After deletion, a total of 23 retrieval results overlap, and the remaining 320 results serve as the final initial document material.

(3) Initial literature screening: As international research and development networks are usually launched in various forms, such as project-based cooperation, establishment of research and development alliances, independent establishment of overseas institutions, etc., the literature materials for international research and development networks may not clearly indicate that the research objects belong to international research and development networks. Therefore, the initial screening is mainly determined by reading the "abstract" of the paper: if the research content of the document involves international research and development, including project-based cooperation,

research and development alliance, independent establishment of overseas institutions, etc., the document passes the screening, otherwise, it will not pass. In order to ensure the reliability of the initial screening results, this study invited two experts to conduct a collaborative review, which can only be adopted if there is agreement. This round of screening yielded 197 results.

(4) Literature secondary screening: secondary screening mainly through in-depth analysis of the paper, and then refine the factors affecting the construction and management of China's enterprises' international research and development network. The criteria for this screening are: if the literature material contains the influencing factors of the construction and management of China's enterprises' international research and development network, it is screened: if the literature material does not contain the influencing factors of the construction and management of China's enterprises' international research and development network, it is discarded. This round of screening yielded a total of 75 retrieval results.

### 2.3 Data encoding method

The data coding in this study is a process of refining and summarizing the relationship model of internationalization R&D network of Chinese enterprises and its restrictive factors, and finally coding layer by layer. Open coding is the initial link of grounded theory. The focus of this link is to decompose, integrate and re-refine the initial data materials to obtain new data that are conceptualized and categorized [13]. Spindle coding is a process of obtaining the main category by comparing different categories and regrouping them according to their correlation and attributes on the basis of open coding [14]. Selection coding is a process of refining the "core" categories of other categories on the basis of open coding and spindle coding, and connecting all categories together through the "story line" method [15]. In order to ensure the reliability of the study, this study invited several experts to cooperate to ensure the reliability of the coding.

## 3. Data encoding process and results

### 3.1 Open coding

Open coding is a process of conceptualizing and categorizing existing data. The specific steps of open coding include: (1) re-integrating the 75 selected documents and materials, finding out the factors and conditions that may affect the construction and management of China's enterprises' international research and development network, refining the words to conceptualize and extract the initial categories, and extracting 124 initial categories in this study; (2) Based on the initial category, the initial category with similar mechanism is classified into the same subcategory by analogy, and 56 subcategories are obtained. In the coding process, "a" is coded at the end of the initial category obtained after conceptualization, and "a" is coded at the end of the subcategory after the initial category is attributed.

### 3.2 Spindle code

Spindle coding is a process of finding rules and reconstructing relationships between different subcategories. This research is based on the logical paradigm of "situation expression  $\rightarrow$  behavior strategy  $\rightarrow$  conclusion/result" [16], integrating the sub-categories conforming to the situation and refining the new main category. For example, "knowledge overflow", "knowledge interaction", "knowledge flow" and "knowledge communication channel" can be integrated into the same category on the same main axis. The main enterprises in the international research and development network establish various channels of knowledge exchange, overflow knowledge through different knowledge flows, and form the result of knowledge interaction. Based on this logical paradigm, this study has summed up 14 major categories (see Table 1).

Table 1 Spindle Code

| Main category                 | Subcategory   |
|-------------------------------|---|
| Network Knowledge Interaction | Knowledge Spillover, Knowledge Interaction, Knowledge Flow, Knowledge Exchange Channels |

|  |  |
|--|--|
| Network technology interaction                       | Technology Spillover, Technology Acquisition Ability, R&D Technology Strength  |
| Network subject interaction                          | Relationship cost, project cooperation intensity, research and development subject interaction, network subject location, cooperation relationship   |
| Network embedding                                    | Network Embedding Elements, R&D Local Embedding, Network Embedding Mode, Network Embedding Dilemma   |
| Network organization mode                            | Research and development organization structure, research and development organization form, research and development mode   |
| Technical Barriers to R&D                            | Research and Development Task Allocation, Competition Effect, Interest Group Conflict  |
| R&D Policy Barriers                                  | Policy Tools, Legal Environment, Host Country Crisis, Government Quality   |
| Talent resources                                     | Talent Resources, Talent Agglomeration Effect, Right of Abode Abroad, Talent Flow  |
| Research and Development Output Protection Mechanism | Intellectual Property Protection and Integration of Research and Development Achievements  |
| System quality                                       | Institutional System, Government Subsidy, Policy Support   |
| Research and development strategy                    | Talent localization strategy, strategic position, alliance strategy, research and development strategy, internationalization strategy  |
| Market capacity                                      | Market conditions, host country's development level, industry characteristics, research and development relevance  |
| Infrastructure resources                             | Conditions of investment, research and development experience, scientific and technological capabilities, research and development investment, basic resource strength, political connections, resource redundancy |
| Characteristics of emerging economies                | Extrusion effect, R&D spillover, outsiders' disadvantage, technology dependence, and low-end locking of technology   |

### 3.3 Core coding

The task of selecting coding is to describe the whole phenomenon by using the scenario of story line, refine the main category, and boil it down to the core category containing all other categories. Through continuous comparison, induction and summary of all major categories, this study finds that the four core categories of enterprise's own capability endowment, network organization structure, network relationship interaction, and characteristics of latecomer economies basically describe the factors affecting the construction and management of China's enterprises' international R&D network completely. Among them, human resources, market capacity, protection mechanism of R&D output, infrastructure resources and R&D strategy are all the enterprise's own capabilities. However, network embeddedness, network organization mode and system quality are attributed to the core category of network organization characteristics, which reflect the influence of network organization structure on the construction and management of China's enterprises' international R&D network at different

levels. On the other hand, network knowledge interaction, network technology interaction and network subject interaction are the interactions between network subjects. Whether knowledge or technology interaction or the relationship interaction between subject enterprises, they are all a kind of transfer of resources within the network. Therefore, they all come under the core category of network relationship interaction. However, the technological barriers and policy barriers set up by other R&D enterprises or host countries to China and the characteristics of emerging economies of Chinese enterprises are the late-development characteristics of Chinese enterprises in building and managing internationalized R&D networks (Table 2).

The stories extracted from these four core categories in this study refer to: on the basis of the obvious characteristics of late-developing economies, China's international research and development enterprises need to improve their own capability endowment and establish good relations and interactions with other main enterprises in the research and development network to adapt to the network organizational characteristics of China's enterprises' international research and development, and seek their own role positioning in the network to effectively manage the research and development network.

Table 2 Core Coding

| Core category                          | Principal axis category  |
|--|--|
| Enterprise capability endowment        | Human resources, research and development output protection mechanism, infrastructure resources, research and development strategy |
| Network organizational characteristics | Network Embedding, Network Organization Model and System Quality   |
| Network relation interaction           | Network knowledge interaction, network technology interaction, network subject interaction   |
| Latent feature                         | R&D Policy Barriers, R&D Technical Barriers, Characteristics of Emerging Economies, Market Capabilities                            |

## 4. Research on Relationship Model and Its Restrictive Factors

### 4.1 Enterprise capability endowment

Enterprise capability endowments include human resources, market capabilities, infrastructure resources, research and development strategies, etc. What role Chinese enterprises play in the construction of international networks and how to achieve results should be based on their own capability endowments. As a typical representative of enterprises in late-developing economies, Chinese enterprises actively integrate into the international R&D network by virtue of the abundant resources and low-cost labor market. However, this marginalized participation mode makes China have obvious low-end locking phenomenon in the international R&D network, which makes it difficult to improve the R&D capability and market possession capability. The division of labor among Chinese enterprises in the international R&D network is obviously at a disadvantage. It is generally believed that China's international R&D enterprises lack high-tech R&D talents and core R&D technologies, and their absorptive capacity in R&D activities is too weak. This gap in innovation capability makes China rely on developed countries for a long time to carry out marginalized R&D activities. At the same time, insufficient technical support and lack of infrastructure resources are another major reason for this phenomenon. The short board of our multinational enterprises' own resources makes our country only come into contact with simple repetitive work at the end of the production chain in the vertical division system of the international research and development network, and it is difficult to master the core technology, which is not conducive to the formation of independent research and development system for our international research and development enterprises [17]. The serious shortage of domestic demand and the deviation of research and development strategy have led China's international research and development enterprises to adopt the export-oriented chain mode of OEM instead of the inward chain

mode relying on the domestic market, which has kept China's international research and development enterprises at the low end of international research and development activities for a long time [18].

#### 4.2 Network organizational characteristics

The characteristics of network organization are the key to the construction of China's international research and development network, which can directly affect the foundation stability of China's international research and development network. Network embeddedness, network organization mode and system quality affect the construction of China's international research and development network from different levels. Network embeddedness refers to which embeddedness method is chosen before network construction. It is generally believed that the embedding methods of international research and development network include the establishment of overseas research and development institutions, the establishment of strategic alliances and cross-border mergers and acquisitions. The establishment of overseas research and development institutions is an important way to promote our country to directly face overseas markets, rapidly capture international information, network overseas talents, and keep up with the international advanced pace [19], which usually requires multinational enterprises to have independent research and development funds and complete research and development system, and to be able to independently carry out research and development of new technologies and new products under the strong technical support of enterprises. However, the way of establishing strategic alliance generally exists between multinational enterprises with advantageous core technologies in developed countries. The way of strategic alliance is conducive to multinational enterprises in the alliance to learn from each other's innovative assets, or to jointly build innovative resources through powerful alliances. The establishment of this method depends on the differences in capabilities among multinational enterprises. Enterprises with small differences in capabilities are more likely to establish this relationship and form complementary resources to jointly enhance their international R&D capabilities. However, cross-border mergers and acquisitions are more common among multinational enterprises that lack advanced knowledge and technology resources. The disadvantage of lack of core technology resources makes some enterprises seek more occupation and absorption of technology, including exclusive knowledge resources that do not exist in the market or are difficult to find. However, the network organization mode determines whether China's international R&D network is a tie network dominated by organizational personnel or capital under different market and technological environments [20]. System quality is the guarantee mechanism of research and development network. Dictatorship management determines the unidirectionality of the network, while decentralized management determines the multidirectional of the network. As a latecomer economy enterprise, under the condition of inferior technological capability endowment, our country chooses the way of cross-border mergers and acquisitions, uses capital as a link, increases investment, and through appropriate institutional constraints, can cross the technological gap, quickly grasp exclusive technological resources, and realize technological catch-up.

#### 4.3 Network relation interaction

The measures of relationship interaction usually include trust, communication and information sharing [21]. Trust and communication mainly refer to the interaction between network subjects, while information sharing usually refers to the knowledge interaction and technology interaction in the network. The basis of information sharing among networks lies in network trust and network communication. Effective communication can help partners understand their wishes and reduce unnecessary conflicts [22]. Knowledge and technology as well as interaction among personnel in international research and development networks are the results and manifestations of internal circulation of network resources. The flow of knowledge and technology in the network determines whether the network is unidirectional or multidirectional. Unidirectional dominance of research and development network refers to the fact that a member of the network diffuses resources rather than acquires them in the process of resource flow, while multidirectional dominance of research and development network refers to the mutual diffusion and acquisition of resources by member

enterprises in the process of resource flow. As a country with a latecomer economy, China pays more attention to the absorption of knowledge/technology in the process of network construction. Therefore, China is more inclined to take capital as a link, adopt the way of overseas mergers and acquisitions, and establish a cooperation network by increasing investment in order to seek greater benefit sharing. From this perspective, the interaction of network relations also determines the organizational structure of China's international research and development network. In addition, the interaction of network entities means that in the operation and maintenance of the initial stage, the development stage and the end stage of the network relationship, the trusted network relationship among network members is conducive to generating tacit understanding and reaching consensus in the innovation activities, thus forming an orderly network convention [23]. The formation of the network convention standardizes the protection mechanism of the network market and research and development output, and can effectively improve the knowledge/technology acquisition capability of Chinese enterprises in the network. For China's international R&D enterprises, good interaction of network relations can promote the formation of network practices, thus improving the capability endowment of China's enterprises. On the other hand, the tense international relations between Chinese enterprises and other network members have caused China to suffer from serious policy barriers and technical barriers. In recent years, research and development cooperation has been aborted frequently, making it difficult for China to carry out international research.

Generally speaking, the interaction of network relations is the core of the smooth progress of internationalization research and development of Chinese enterprises. Knowledge/technology interaction among networks can determine the network organizational structure of China's international research and development, while good network subject interaction can enhance the capability endowment of Chinese enterprises, reduce the research and development strength gap between Chinese enterprises and enterprises in other developed countries, at the same time ease the international relations between enterprises and reduce the possibility of Chinese enterprises suffering from technical barriers and policy barriers in the network. Therefore, relationship governance should be taken as the basis for the governance of China's international research and development network, and good relationship interaction is more conducive to the construction and management of China's international network. Research and development enterprises in an international research and development network have two perspectives in management. Institutional-based relationship governance is applicable to networks that require non-linear and changeable collaborative cooperation, while emotional-based relationship governance is helpful to realize highly embedded knowledge flow in networks [24]. As a latecomer economy enterprise, China's enterprises are currently more seeking high embeddedness of knowledge flow. Therefore, relationship management based on emotion may be more suitable for China's enterprises to carry out international R&D network management.

#### **4.4 Network relation interaction**

As the representative of enterprises in the late-developing economies, China's international R&D enterprises have typical late-developing characteristics, and at the same time encounter serious policy barriers and technical barriers. The impact of China's expanding overseas research and development activities and increasingly strong investment scale on relevant host country enterprises has gradually increased, causing these countries to compete with China's technical supervision and policies in overseas research and development activities. The number of cases in which Chinese enterprises' overseas R&D and M&A activities were aborted due to technical barriers and policy barriers rose gradually, soaring to 19 in 2011, and the loss due to overseas M&A failures reached 36.5 billion US dollars in 2016, 18 times as much as in 2015 [25-26]. The barrier boycotts that our country encountered mainly came from the United States. In the early days, the United States adopted a comprehensive boycott of the embargo to cut off the contact between Chinese enterprises and high-tech enterprises. In the 1970s, in order to resist the Soviet Union, the United States relaxed its control policy on Chinese multinational enterprises and locked in its technology. However, with the gradual rise of China's national strength, the United States has re-enlarged the scope of its "containment" and

"contact" policies under the crisis consciousness, and strengthened its technical attack and policy control on China's international R&D enterprises [27]. The technical barriers and policy barriers set up by the United States are basically due to their close and distant relationship with other cooperating countries [28]. As a developing country with tense relationship with the United States, the barriers encountered by China's investment in the United States are mainly reflected in the security review conducted by its Foreign Investment Committee, the anti-monopoly review conducted by relevant agencies and the strike policy implemented by the United States Congress driven by the activities of interest groups [29]. As China's leading international research and development company, Huawei has been blocked frequently in the U.S. market in recent years. In 2008, Huawei attempted to acquire 3COM with Bain Capital, which was rejected by the US Foreign Investment Committee. In 2009, AT&T reached a 4G equipment contract with Huawei and was intervened by the US National Security Agency. In 2010, Huawei's attempt to acquire Motorola's wireless assets was rejected by the U.S. government, and its attempt to acquire broadband network manufacturer 2wire also failed. The 4G equipment contract with Sprint was interfered by the U.S. department of commerce. In 2018, the "Five Eyes Alliance" jointly boycotted Huawei 5G technology, making it difficult for Chinese enterprises to step forward in the process of building a national network. The internal reason lies in the gradual improvement of the industrial structure of China's international R&D enterprises, the steady improvement of market competitiveness, and the loss of the advantages previously occupied by developed countries, which in turn poses a threat to the relevant host countries. The external reason is that developed countries, represented by the United States, have changed their open attitude in order to cater to the people to gain the ruling power, and have adopted protectionism instead, using the policy supervision system to protect their own interests [30]. Under such circumstances, international interest competition and political game are intensifying, and China's international research and development activities are inefficient and difficult to carry out.

## 5. Conclusion and Management Enlightenment

### 5.1 Conclusion

Based on grounded theory and coding analysis of a large number of documents, this study extracts the sub-categories, main categories and core categories of influencing factors for the construction and management of China's enterprises' international research and development network. Through the scenario representation of the story line, the category and category are linked into a unified framework:

(1) The four core categories that affect the construction and management of China's internationalized R&D network are enterprise capability endowment, network organization structure, network relationship interaction and late-development characteristics. These four core categories include 14 main categories and condensed the connotation of 57 sub-categories.

(2) The story line connection of enterprise capability endowment, network organization structure, network relationship interaction and late-development characteristics refers to: on the basis of obvious late-development characteristics, China's international R&D enterprises need to improve their capability endowment, establish good relationship interaction with other main enterprises in the R&D network, and select the appropriate network organization structure in order to build a harmonious and stable development of international R&D network, and seek their own role in the network to effectively manage the R&D network. Among them, the interaction of network relations can determine the organizational structure of the network to some extent, positively adjust the enterprise's own ability endowment, and good interaction of relations can also reduce the possibility of Chinese enterprises suffering from policy barriers and technical barriers in the network, and offset the negative effect of the later disadvantage on the construction and management of the internationalization research and development network of Chinese enterprises.

### 5.2 Management inspiration

(1) As a big manufacturing country, China lags behind developed countries such as Europe and the United States in this field, and its independent innovation capability is obviously insufficient. The



embedding method of cross-border mergers and acquisitions can effectively make up for the defects in China's innovation capability, rapidly absorb the lack of knowledge/technology resources, occupy the absolute control of local enterprises, and shape the unique core competitiveness of China's international R&D enterprises. Through overseas mergers and acquisitions embedded in the global research and development network, most of China's multinational enterprises can overcome their own shortcomings, cross the innovation gap, realize the further catch-up of technology, and enhance the core competitiveness of their own enterprises in the world.

(2) As a latecomer economy enterprise, it can develop advanced production factors and introduce high-tech labor to help the enterprise realize transformation and upgrading. On this basis, it can accumulate its own strength and build a vertically integrated research and development chain with self as the core within the region. At the same time, we should create a mother-effect city, enhance our self-innovation ability, and break through the low-end lock-in phenomenon of China's international research and development enterprises through policy subsidies. From a short-term perspective, a gradual breakthrough path can be adopted, through the expansion path of production capacity, technical capacity and marketing capacity, the introduction and transformation of high and new technologies, the realization of endogenous research and development innovation, and the realization of independent innovation internationalization. From a long-term perspective, we can take a breakthrough path by leaps and bounds. We can use the attraction of technology and market to introduce advanced research and development capacity into other developing countries or underdeveloped countries, carry out self-dominated value chain cooperative research and development activities, and build our own-dominated national research and development network through extending the value chain to break through the phenomenon of low-end locking. As a big manufacturing country, it should respond to "intelligent manufacturing", break the "comparative advantage trap" of relying on cheap labor market for industrial development, and implement the "intelligent manufacturing" strategy under the guidance of policies.

(3) Promoting independent research and development capability, enhancing national scientific and technological innovation capability and optimizing policies to attract professionals to return are important ways for China to break the barriers of international research and development policies. At the same time, a reasonable choice of investment opportunity and investment location can reduce the possibility of encountering policy barriers, and at the same time enhance the compatibility of the development direction between China's R&D enterprises and host country enterprises [38]. The lack of social responsibility system is also considered to be an important reason for China's international research and development to encounter policy barriers, while the establishment of a good corporate culture, the formulation of long-term implementable strategies and the construction of a public relations information platform can effectively alleviate the problem.

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