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R&D Internationalization and Innovation Performance: Evidence from Chinese Enterprises

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Abstract

In the process of R&D internationalization, enterprises in emerging economies represented by China seek advanced knowledge and technological resources from overseas to improve their innovation capability and performance. Taking the listed companies in Chinese information technology industry from 2009 to 2020 as the research sample, this paper investigates the impact mechanism of R&D internationalization on innovation performance, and tests the moderating effects of state-owned equity and absorptive capacity on the relationship between them. The empirical findings show that R&D internationalization significantly improves enterprise's innovation performance, and both state-owned equity and absorptive capacity positively moderate the relationship. This enlightens that in the process of R&D internationalization, emerging multinational enterprises can not only obtain the support and services from the home government by increasing the proportion of state-owned equity or establishing political connections, but can also better realize the absorption and transformation of external advanced knowledge and technology by increasing R&D investment, thereby improving the enterprises' innovation performance.

Key words: R&D Internationalization, Innovation Performance, State-owned Equity, Absorptive Capacity

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1. Introduction

With the deepening of economic globalization and enterprise internationalization, transnational competition among industries is becoming increasingly intense, and innovation has become an important source for enterprises to create and maintain competitive advantage in the global market (Filatotchev & Piesse, 2009). Therefore, many companies, especially multinational corporations (MNCs) in developed countries, have gone to other countries to seek knowledge and internationalize their R&D activities (Dunning & Lundan, 2009). They are no longer satisfied with simply transferring their production, manufacturing, or sales links to the rest of the world, but are taking the lead in transferring their R&D activities in the upstream links of the enterprise value chain overseas, to give full play to their own technological advantages while also utilizing the host country's advanced scientific and technological resources (Vernon, 1966; Li Mei & Yu Tianjiao, 2016). Carry out R&D internationalization by seeking and allocating R&D resources globally as efficiently as possible.

As latecomers to the global economy, emerging multinational corporations (EMNCs) differ from their counterparts in developed countries in terms of size, management know-how, and other firm-specific intangible assets. In order to survive and grow in a highly competitive environment, as well as to adapt to the transition of the economic and institutional environment, EMNCs are paying more attention to innovation activities in enhancing their market positioning, organizational renewal, and transformation as they catch up with the resource-rich MNCs from developed countries (Luo & Tung, 2007). Particularly late-developing MNCs from emerging economies, such as China, India, and Russia, have also taken the internationalization of R&D activities as their "springboard" strategy, to obtain advanced technical knowledge that can improve their innovation ability from overseas (Li Mei et al., 2020).

However, the existing relevant literature has not reached a consistent conclusion on whether R&D internationalization really helps MNCs to improve their innovation ability and performance. Most scholars support the view that R&D internationalization has a positive effect on the innovation performance of MNCs (Kafouros et al. 2008; Lööf, 2009; Li Mei & Yu Tianjiao, 2016), and encourages the diffusion of innovations between the parent company and its foreign subsidiaries, because it can obtain innovation resources and diversified technological learning opportunities all over the world through R&D internationalization

(Penner-Hahn & Shaver, 2005; Cantwell & Mudambi, 2005; Arvanitis & Hollenstein, 2011). Conversely, some scholars believe that R&D internationalization may have a negative effect on the innovation performance of multinational enterprises due to the lack of technology absorption capacity, the liability of foreignness, the geographic dispersion, and the coordination and governance costs (Argyre & Silverman, 2004; Sofka, 2008; Singh, 2008). In addition, there are a few scholars even concluded that the relationship between R&D internationalization and MNCs' innovation performance is quadratic (u-shaped or inverted u-shaped) or cubic curve (s-shaped) (Lahiri, 2010; Hsu et al., 2015; He Jian-hong & Zhong Yan, 2019).

The main reason for the above disputes is the difference in research objects. The existing research on the R&D internationalization and innovation performance of MNCs mostly takes MNCs in developed countries as the sample. As the international R&D activities of MNCs in developing countries and emerging economies have begun to be active in recent years, the study taking them as the research sample has emerged late and is relatively rare. And as mentioned above, the R&D internationalization of MNCs in developing countries and emerging economies shows completely different characteristics from that in developed countries. Besides, due to the great difference in development track, technological innovation demand and upgrading speed among industries, the different industry categories and data sampling time of the sample enterprises in the relevant research are also the reasons for the inconsistent conclusions.

Moreover, scholars began to further explore whether some factors moderate the relationship between R&D internationalization and innovation performance. Most of the existing studies are based on the perspective of resources to explore the factors that moderate the relationship between the two, such as the parent company's previous overseas expansion experience, organizational redundancy, the diversity of technical resources owned and mastered by the parent company, and domestic R&D investment (Lahiri, 2010; Chen et al., 2012; Belderbos et al., 2015). However, from the perspective of the home country institutions, there is a lack of research on the influence mechanism of state-owned equity of enterprises in emerging economies. In fact, governments in emerging markets have the control over market resources, and establishing a good relationship with the government is helpful for enterprises to obtain information related to government policies, obtain valuable resources, and financing

convenience (Peng & Zhou, 2005), thus promoting the international development of enterprises and bringing competitive advantages. Especially in China, state-owned enterprises (SOEs) are owned or controlled by the state over their capital, and supervised and managed by the State Council or local governments. They are the pillar of national economic development and socialism with Chinese characteristics. Therefore, with absolute state-owned equity, SOEs are considered to have relatively more support in information, funds and other resources, and may have greater advantages in the international development of R&D.

In addition, based on the perspective of reverse knowledge transfer, some existing literature has investigated the impact of enterprises' absorptive capacity on the relationship between R&D internationalization and innovation performance (Wu et al., 2016; Chen Yuping et al., 2020). But these studies either take MNCs in developed countries as the research samples, or ignore the importance of enterprise R&D personnel, and only measure the absorption capacity of sample enterprises by the proportion of R&D investment in operating revenue. The research method is relatively single and has certain limitations.

Based on the above analysis, this paper takes the MNCs of China, a typical emerging economy, as the representative, selects the companies in the information technology industry listed on the Shenzhen Main-board Market from 2009 to 2020 as the investigation sample, and focuses on the following three questions: First, under the background of emerging economies, does the R&D internationalization behaviors have a significant impact on the enterprises' innovation performance? Second, in the context of socialism with Chinese characteristics, whether and how does state-owned equity moderate the relationship between R&D internationalization and innovation performance? Third, after replacing the measurement method with R&D personnel, whether and how does the enterprises' absorptive capacity moderate the relationship between R&D internationalization and innovation performance? It is expected to provide some enlightenment for the development of R&D internationalization and the improvement of innovation performance of MNCs in China and other developing countries and emerging economies, to promote their strategic transformation, innovation catch-up, and even "curve overtaking".

The rest of the paper is organized as follows. The second part puts forward the research hypothesis based on the theoretical analysis. The third part introduces the methodology, including samples, data sources, and variables. The fourth part is the empirical analysis and

results. The fifth part is the research conclusion, including contributions, limitations and future research.

2. Theoretical foundations and hypotheses development

2.1. R&D internationalization and enterprises' innovation performance

R&D internationalization refers to an enterprise's overseas R&D investment. With the intensification of global market competition, in order to stand out from competitors in the same industry, more and more MNCs begin to enter the international market to seek advanced technical resources and knowledge to improve their innovation capability and establish international competitive advantage. Through establishing R&D institutions or subsidiaries in other countries or regions and carrying out R&D alliance cooperation with international partners to optimize the layout of enterprises' R&D activities in all regions of the world, to maximize the integration of the existing technical advantages of the enterprise and the advanced scientific and technological resources of the host country, seek and absorb high-quality external knowledge all over the world, to realize the optimization of the global allocation of enterprise R&D resources. Now, R&D internationalization has become an important way for most MNCs to maintain competitive advantage, obtain innovation resources and improve innovation capability. In addition, it has gradually become the research focus in the fields of technological innovation management, transnational management, strategic management, and so on.

Existing studies on R&D internationalization have focused on a wide range of issues including the motivation (antecedents), development modes, and the output (consequences). Research investigating the motives of R&D internationalization has identified market-seeking (Von Zedtwitz & Gassmann, 2002; Liu et al., 2010), technology-seeking (Di Minin et al., 2012; Li Mei & Yu Tianjiao, 2016) as primary motives. Related studies discussed additional motivations such as cost reduction (Sun Fuquan et al., 2006), skilled local talent, or other complementary assets (Serapio & Dalton, 1999), the host country's environmental factors include intellectual property protection mechanism, tax preference, government subsidies and technical and cultural proximity (Ambos et al., 2011; Grimes & Miozzo, 2015). Studies on the

development modes of R&D internationalization include W Kuemmerle's (1997) classification of two different types of R&D institutions according to their functions: home-based exploiting (HBE) and home-based augmenting (HBA). Gassmann and Von Zedtwitz (1999) classified international R&D organizations into five different types according to the firm's dispersion of R&D activities and the degree of cooperation between individual R&D units. As for the choice of investment mode and location for R&D internationalization, some scholars believe that cultural differences, transaction costs, institutional distance, market environment, and other factors will affect the investment mode selection of enterprises in international R&D activities (Kogut & Singh, 1988; Picci, 2010; David Ryfisch, 2015). Some scholars believe that the key determinant of the degree of knowledge and resources acquired by foreign-invested enterprises is location choice (Chen Yantai et al., 2016). About the studies on the consequences of R&D internationalization, except that few scholars have studied whether R&D internationalization can have a significant impact on the productivity of the parent company (Todo & Shimizutani, 2008; Belderbos et al., 2015), most scholars focus on innovation performance (Hitt et al., 1997; Singh, 2008; Hsu et al., 2015; Li Mei & Yu Tianjiao, 2016).

Theoretical and empirical studies on the enterprises' internationalization strategy are becoming more and more mature, and the research findings on the impact of R&D internationalization on the innovation performance of MNCs are also abundant. Based on different theoretical perspectives, the relevant studies are summarized as follows.

Firstly, in the knowledge-based view, the company is regarded as a knowledge processing system, and knowledge is an important strategic resource of the company's core competitiveness (Foss, 1996). Some scholars believe that entering a new country enables companies to obtain the transfer three types of knowledge related to market, technology, and social system (Hsu & Pereira, 2008; Wang Zhanshuo & Xie Wei, 2018), and the wider the geographical distribution of international R&D cooperation, the higher the availability of knowledge heterogeneity. When the company sets up overseas R&D subsidiaries in the host country, the knowledge transfer can reach the highest level (Zahra et al., 2000). Kotabe and Mishra (2007) believe that there is a curvilinear relationship between transnational knowledge transfer and innovation performance. Low- and medium-level international knowledge content improves innovation performance, while high-level international knowledge content reduces the marginal reward of overseas knowledge transfer. Hollenstein (2011) found that knowledge-

driven overseas R&D activities can positively affect the innovation output of enterprises through the reverse spillover of knowledge.

Secondly, in the resource-based view, scholars believe that the resources and capabilities of MNCs are significantly different (Brouthers & Hennart, 2007), and the establishment of overseas R&D institutions can help enterprises obtain global resources (Cordell, 1997). Arvanitis and Hollenstein (2011) support the view that R&D internationalization has a positive effect on the innovation capability of MNCs, and believe that through R&D internationalization, enterprises can significantly improve the innovation capability of parent companies by obtaining innovation resources and diversified technological learning opportunities in the world.

Then, based on the perspective of industrial organization theory, Criscuolo et al. (2005) found that R&D personnel in enterprises with international R&D are more diversified, which can promote the exchange and collision of various ideas and knowledge, and finally enhance the innovation capabilities of enterprises.

Finally, in institutional theory, the institution is regarded as a series of formal or informal rules or social norms, which mainly solves the problem of how organizations obtain legitimacy in the host country by optimizing the structure and adjusting behaviors (Andrews et al., 1993). According to Argreyes, Silverman (2004) and Singh (2008), the enterprise needs to invest a lot of costs in the process of establishing legitimacy and obtaining social support in the host country, including transaction costs, communication and coordination costs, and management costs, which has a negative impact on innovation performance. CHH (2008), Deng Haibin and Liao Jinzhong (2010) investigated the impact of institutional variables such as intellectual property protection, higher education system, business convenience, and market economy on international R&D spillovers. The results show that the institutional quality has an important impact on international R&D spillovers, and countries with high institutional quality can obtain more R&D spillovers from international R&D activities.

Although the current research on R&D internationalization is more focused on enterprises in developed countries, R&D internationalization still provides an opportunity for MNCs in emerging economies who are original “technology followers” and “market latecomers” (Li Mei & Yu Tianjiao, 2016), the rapidly rising MNCs in emerging economies are becoming one of the most significant changes in today’s global competition pattern (Ramamurti & Singh, 2009).

Therefore, scholars have gradually begun to pay attention to the research on R&D internationalization and innovation performance of emerging economies. It is found that MNCs in these emerging economies often adopt imitation and catch-up strategies. And the function of overseas R&D subsidiaries is to reverse transfer the advanced technical knowledge and experience acquired from overseas to the parent company that is in a technologically backward position, which will act on the improvement of the parent company's innovation capability (Awate et al., 2015; Peng et al., 2017). Therefore, we expect that for EMNCs in the information technology industry in China, a typical emerging economy, R&D internationalization can also positively promote innovation performance.

Based on the above analysis, this paper proposes hypothesis 1.

H1. There is a positive relationship between R&D internationalization and innovation performance of MNCs in emerging economies.

2.2. Moderating effect of state-owned equity

State-owned equity, as an important dimension in the institutional arrangement of emerging economies, is a rule-level institutional influencing factor (Hill & Snell, 1989; Hong H et al., 2016), an essential situational factor in the study of internationalization strategy and performance of late-comer MNCs. Most scholars explain the positive effects of state-owned equity from the perspective of resource-based theory. As an open but non fully autonomous organization system, enterprises are facing a dynamic external environment and high dependence on external resources (Hillman et al., 2009). Wang Junqiu (2013) and Liu Lin (2016) found that the political connection established by state-owned equity can not only bring many direct external resources to enterprises, including financial subsidies, tax incentives, bank financing facilities, policy preferential loans, and industry access permits, but also establish a reputation mechanism for enterprises and create indirect market advantages, such as reducing the cost of equity capital and reducing investors' risk evaluation of the enterprise. But different from private capital, state-owned equity is more politically sensitive and more reflects the national will, and is relatively unresponsive to the market (Peng et al., 2008), its negative impact cannot be ignored. For example, internationalization and innovation activities are highly interfered by the government, and may require the same or even more attention to government objectives rather than just their own innovation objectives. Moreover, the state-owned identity

is also vulnerable to the liability of foreignness, the distrust and institutional constraints of the host country (Li Mei & Yu Tianjiao, 2016). Therefore, in the context of the Chinese scenario, the introduction of state-owned equity variables will help to further discover the impact mechanism between R&D internationalization and innovation performance (Chen Yantai et al., 2019).

Based on the analysis and summary of relevant prior studies, it is found that the impact of state-owned equity on the innovation performance of enterprises has two sides: on the one hand, the increase in the proportion of state-owned equity can reduce the financing constraints of enterprises; while obtaining more preferential policies and resource advantages, such as prime-based loans, government subsidies, and overseas technical information, which are conducive to improving the innovation performance of enterprises (Chen Yantai et al., 2019; Sun Yu, 2020). On the other hand, a high proportion of state-owned equity will aggravate the social responsibility of enterprises. For example, many SOEs have excessive employees to solve the employment problem (Sun Yu, 2020). Moreover, due to the high level of government intervention, the senior management team will deviate from the corporate interests to a certain extent based on the government pressure when formulating international strategies, which will have a negative impact on the innovation performance of enterprises (Li Mei & Yu Tianjiao, 2016; Chen Yantai et al., 2019).

This paper holds that for MNCs in emerging economies, not only does R&D internationalization can improve the innovation performance, but also this effect will be affected by the parent company's state-owned equity. Although some scholars believe that enterprises with a higher proportion of state-owned equity need to shoulder more social responsibilities and have less autonomy in formulating internationalization strategies (Ramamurti, 2001; Wu Qingming, 2017). But, in the context of socialism with Chinese characteristics, the Chinese government has always adhered to the basic national policy of opening up and has been developing an open economy, implementing the "Go global" strategy to encourage enterprises, especially SOEs, to actively expand international economic and technological cooperation, actively explore market space, adjust industrial structure, obtain technical resources and optimize resource allocation, so as to improve the competitiveness of enterprises, move forward to the high value-added link of the industrial chain, enhance China's role in the international division of labor. Therefore, in order to support and encourage all kinds

of qualified Chinese enterprises to go global, the Chinese government has adopted a series of policies and measures, and provided a variety of services. For example, a series of economic support such as loan discounts, credit, and project funds, policies and measures such as insurance, customs clearance, multilateral economic and trade contact mechanism, and consular protection, as well as information consulting services to provide investment information and overseas market information of various countries and regions. Therefore, we expect that enterprises in emerging economies with a higher proportion of state-owned equity, especially SOEs, in the process of R&D internationalization, will preferentially obtain more economic, policy, and information support due to their inherent advantages of political connection, and thus are likely to obtain more innovation resources earlier and improve their innovation performance.

Based on the above analysis, this paper proposes hypothesis 2.

H2. For MNCs in emerging economies, state-owned equity positively moderates the effect of R&D internationalization on innovation performance.

2.3. Moderating effect of absorption capacity

Cohen and Levinthal (1990) defined firm's absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends", and argue that firm's absorptive capacity is critical to its innovative capabilities (Lane et al., 2001; He Ai & Zhong Jingwen; 2018). Zahra and George (2002) extended the definition of absorptive capacity based on the dynamic capacity theory, considered that absorptive capacity is a dynamic process, that has the following four components: knowledge acquisition, assimilation, transformation, and exploitation. Based on the first two classic literatures, Patterson and Ambrosini (2015) summarized and further proposed that absorptive capacity is a dynamic capability which creates new firm resources by searching, acquiring, assimilating, transforming, and exploiting external knowledge with internal resources, and acting as a process framework for innovation.

As for the previous research related to absorption capacity, Zahra and George (2002) have already proposed that there is a significant positive correlation between absorptive capacity and enterprise innovation when summarizing the research on absorptive capacity. And in addition to a large number of existing research has confirmed that the absorptive capacity of

enterprises, as a by-product of R&D investment, has a significant role in promoting the innovation output and innovation performance of enterprises (Escribano et al., 2009; Wu et al., 2016), there are also some studies have found that the moderating effect of the absorptive capacity. For example, Escribano et al. (2009), Wang and Han (2011) used corporate sample data from Spain and China, respectively, confirmed that absorptive capacity affects the relationship between knowledge management and corporate innovation performance. Tao Feng (2011) found that absorptive capacity can positively affect the relationship between knowledge spillover and innovation performance. Kang Qingsong (2015) found that the absorptive capacity of enterprises plays a positive role in the process of knowledge transfer and enterprise performance. Wu et al. (2016) also pointed out that the absorptive capacity has a positive moderating effect on the relationship between enterprise internationalization and innovation performance.

Moreover, from the perspective of resource-based theory and knowledge-based theory, the purpose of R&D internationalization of EMNCs is to obtain different and advanced knowledge and resources, to improve their innovation performance. However, the premise of R&D internationalization playing a role is that parent enterprises can effectively acquire and transfer new knowledge and resources obtained from overseas R&D (Yao Liangyan, 2021). And whether an enterprise can obtain valuable heterogeneous knowledge elements from overseas R&D to promote innovation depends on its absorptive capacity (Cohen & Levinthal, 1990). If enterprises lack absorptive capacity to internalize knowledge created by others, and modify it to fit into their existing applications, processes, and routines, they cannot benefit from knowledge acquisition to improve their innovation performance (Masaaki Kotabe et al., 2011). Only when enterprises can effectively absorb external knowledge can the external knowledge stimulate the enterprises' internal R&D activities (Veugelers, 1997).

Therefore, this paper argues that for MNCs in emerging economies, the parent company's absorptive capacity can affect the relationship between R&D internationalization and innovation performance: The stronger the absorptive capacity of an enterprise, the more active it will be in absorbing and learning new knowledge in the process of R&D internationalization, and it is easier to identify and obtain the resources and key information it lacks, and convert them into the R&D capacity, therefore, it is easier to obtain the benefits of innovation (Ito & Wakasugi, 2007; Yao Liangyan, 2021). For enterprises with weak absorptive capacity, because

overseas R&D institutions have different cultural backgrounds and technical underpinnings, are likely to be difficult to absorb and apply the new knowledge and resources they provide, and confront certain obstacles in applying the knowledge obtained from overseas to their innovation activities (Yao Liangyan, 2021).

Based on the above analysis, this paper proposes hypothesis 3.

H3. For MNCs in emerging economies, absorptive capacity positively moderates the effect of R&D internationalization on innovation performance.

To sum up, the theoretical framework of this paper is shown in Fig. 1.

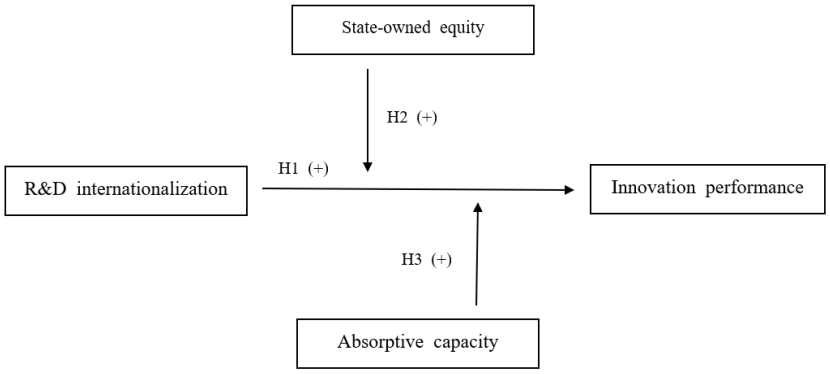

Fig. 1 Theoretical framework

3. Methodology

3.1. Data collection and sample

The samples in this paper are Chinese listed companies in the information technology industry on the Shenzhen Stock Exchange. Considering that the global financial crisis in 2008 may have an important impact on the R&D internationalization of sample enterprises, this paper sets the initial time of the study as 2009 after the financial crisis. Meanwhile, due to the availability of data, the sampling time is up to 2020. Therefore, the research period of the final sample of this paper is set as 2009-2020. Based on the initial sample, this paper filters data according to the following principles: (1) eliminate ST enterprise samples, (2) eliminate the

enterprise samples with serious lack of relevant data and information, (3) eliminate the enterprise samples whose host countries are "tax havens" (such as the Cayman Islands, Bermuda, and the British Virgin Islands). Finally, the enterprise sample data composed of 1456 observations from 170 listed enterprises was obtained.

The reason for choosing the information technology industry is that companies in this industry have relatively active R&D internationalization activities, during the sampling period, up to 67.1%, 114 enterprises have the experience of foreign direct investment. In addition, according to the industry classification standard of the China Securities Regulatory Commission (CSRC), listed companies in the information technology industry are mainly divided into three categories: Telecommunication, radio, television and satellite transmission services (I63), Internet and related services (I64), and Software and information technology services (I65). In the research sample, the number of enterprises in Software and information technology services is 135, accounting for 79.4%. It can be seen from Table 1 that by 2020, the maximum age of the sample enterprises is 36 and the minimum age is 11, and the number of enterprises older than and younger than the average age is almost the same, indicating that China's information technology industry has developed steadily and with a strong momentum over the past 40 years of reform and opening up. Although there is still a gap compared with the old information technology powerhouses represented by the United States, and Chinese companies' price-to-earnings ratio and valuation are far lower than those of their American counterparts. In recent years, the scale of China's information technology industry has expanded rapidly, the average number of employees of the sample enterprises reached 2673 in 2020. And there were only 25 SOEs, accounting for only 14.7%. With a high degree of marketization, full competition, and significantly improved technology level, it has developed into an important part of strategic emerging industries. According to the statistics of the Ministry of Industry and Information Technology of China, in 2020, there were more than 40,000 enterprises with annual revenue of more than 5 million yuan in the Software and information technology services, and the accumulated business revenue reached 8,161.6 billion yuan, up 16.9% year-on-year. As one of the key forces to promote China's new round of scientific and technological revolution and industrial reform, the information technology industry will show a stronger development trend under the promotion of policies. Therefore, taking the listed companies in China's information technology industry as the research sample,

the conclusions and enlightenment can not only enrich the theories related to R&D internationalization and innovation performance in the context of emerging economies, but also provide practical value to promote the development of EMNCs.

Table 1. Demographic Statistics of the Sample

	Min	Mean	Max		Frequency	Percentage
Firm age (years)	11	21.4	36	>21.4 years	74	43.5%
				<21.4 years	96	56.5%
Firm size (employees)	86	2673	22670	>2673 employees	57	33.5%
				<2673 employees	113	66.5%
Firm nature (SOE)				SOE	25	14.7%
				Non-SOE	145	85.3%
Overseas experience (during the sampling period)				Yes	114	67.1%
				No	56	32.9%
I63. Telecommunication, radio, television and satellite transmission services					6	3.5%
I64. Internet and related services					29	17.1%
I65. Software and information technology services					135	79.4%

3.2. Variables and measurement

3.2.1. Dependent variable

Enterprises' Innovation Performance (Patent). For this variable, existing studies generally adopt the following three measures: One is the number of patent applications of enterprises (Ambos & Schlegelmilch, 2007; Zhong Changbiao et al., 2014; Yuan Jianguo et al., 2015; Torres Hurtado, 2018); the second is the number of patents cited (Chen et al., 2012; Hsu, et al., 2015); the third is the sales of new products (Tsai, 2001; Lööf, 2009). Considering the availability of data, this paper uses the number of patent applications to measure the innovation performance of sample enterprises. Patent data comes from the State Intellectual Property Office of China and China Stock Market & Accounting Research Database (CSMAR database).

3.2.2. Independent variables

R&D Internationalization (R&D internationalization). According to Lv Ping et al. (2008) and Zeng Deming et al. (2013), Chinese MNCs can internationalize their R&D activities by establishing, merging or acquiring overseas research institutions, establishing international R&D alliances and carrying out offshore R&D outsourcing. In view of the availability of overseas R&D data of sample enterprises, this paper sets R&D internationalization as a dummy variable by referring to the practices of Penner Hahn and Shaver (2005), Zhong Changbiao et al. (2014), and Li Mei and Yu Tianjiao (2016b). If the enterprise has carried out R&D internationalization activities in the observation year, the value is 1, otherwise, it is 0. The information on the sample enterprises' R&D internationalization comes from the Chinese Research Data Services (CNRDS database) and is supplemented manually from the enterprise's official website and annual reports.

3.2.3. Moderating variables

State-owned equity (SOE). Referring to the studies of Hu Huaxia et al. (2017), Zhang Yujuan & Tang Xiangxi (2018), and Gu Qun et al. (2019), this paper adopts enterprises' property rights to measure state-owned equity. When the sample enterprise is SOE, the value is 1, and when the enterprise is non-SOE, the value is 0. The equity information of the sample enterprises is obtained from the CNRDS database.

Enterprises' absorptive capacity (Absorptive capacity). Cohen and Levinthal (1990) pointed out that an enterprise's absorptive capacity can be measured by its R&D investment. Based on the research of Wu et al. (2016), He Ai and Zhong Jingwen (2018), and Chen Yuping et al. (2020), this paper employs the R&D investment intensity, that is, the proportion of R&D investment in operating revenue represents the enterprises' absorptive capacity. The relevant data of sample enterprises comes from the CSMAR database, and a manual search of the enterprise annual report to supplement some missing information.

3.2.4. Control variables

Referring to the research of Wu et al. (2016), Hsu et al. (2016), and Li Mei et al. (2020), this paper selects profitability (ROA), firm age (Age), enterprise asset (Size) and research personnel (Input) as control variables. The measurement methods of all control variables are shown in

Table 2, and the relevant data of control variables are all from the annual reports of sample enterprises and the CSMAR database.

The detailed description of the above variables is shown in Table 2.

Table 2. Variable definitions and data sources

Items of variables	**Name of variables**	**Description and measurements**	**Data sources**
Dependent variable	Patent	Innovation Performance: measured by the number of patent applications each year.	State Intellectual Property Office of China; CSMAR database
Independent variable	R&D internationalization	R&D internationalization: if the enterprise has carried out R&D internationalization activities, the value is 1, otherwise, it is 0.	CNRDS database; Enterprises' official websites; Enterprises' annual reports
Moderating variables	SOE	State-owned equity: if the sample enterprise is state-owned enterprise, the value is 1, otherwise, it is 0.	CNRDS database
	Absorptive capacity	Enterprises' absorptive capacity: measured by the proportion of R&D investment in operating revenue.	CSMAR database; Enterprises' annual reports
Control variables	ROA	Profitability: measured by the return on assets.	CSMAR database; Enterprises' annual reports
	Age	Firm age: measured by the natural logarithm of the difference between observation year and establishment year.	
	Size	Enterprises' assets: measured by the natural logarithm of the total annual assets.	
	Input	Research personnel: measured by the natural logarithm of the number of research personnel.	

4. Empirical analysis and results

4.1. Descriptive statistics

Before moving on to regression analysis, descriptive statistics have been made in this paper. The mean value, standard deviation, variance inflation factor (VIF), and correlation coefficient matrix of each variable are listed in Table 3. As shown in Table 3, the mean value of the sample enterprises' innovation performance is 24.957, and the standard deviation is 66.117, which is nearly three times the mean value, indicating that the sample enterprises' number of patents is excessively discrete, which indicates that even these listed companies in the same information technology industry still have significant differences in their innovation output. Moreover, the maximum VIF value of all variables is 1.96, and the mean value is 1.39, both of which are lower than the VIF threshold value of 10, indicating that there is no multicollinearity interference between variables. Because the dependent variable in this paper is counting variable with a Poisson distribution, the Poisson fixed effects model is used for regression in the following part to precisely verify and analyze the relationship between various variables.

Table 3. Descriptive statistics and correlations

Variables	Mean	SD	VIF	1	2	3	4	5	6	7	8
1.Patent	24.957	66.117		1							
2.R&D internationalization	.536	.499	1.26	0.118***	1						
3.SOE	.116	.320	1.09	0.169***	-0.151***	1					
4.Absorptive capacity	.114	.091	1.25	0.069***	0.071***	-0.031*	1				
5.ROA	.035	.118	1.08	0.022	-0.092***	-0.010	0.046*	1			
6.Age	2.819	.296	1.18	0.123***	0.153***	0.136***	-0.073***	-0.178***	1		
7.Size	21.387	.928	1.96	0.279***	0.385***	0.133***	-0.035*	-0.0380	0.340***	1	
8.Input	5.924	1.156	1.93	0.259***	0.267***	0.106***	0.336***	0.130***	0.173***	0.577***	1

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.2. Regression analysis

This study employs panel data from listed enterprises in China's information technology industry from 2009 to 2020. The Poisson fixed-effect model is as follows:

$$\text{Patent}_{it} = \beta_0 + \beta_1 \text{R\&D internationalization}_{it} + \beta_2 \text{SOE}_{it} + \beta_3 \text{Absorptive capacity}_{it} + \beta_4 \text{R\&D internationalization}_{it} \times \text{SOE}_{it} + \beta_5 \text{R\&D internationalization}_{it} \times \text{Absorptive capacity}_{it} + \sum \beta_k \text{Controls}_{it} + \varepsilon_{it}$$

Where, i represents the enterprise and t represents the year. Patent is the dependent variable, that is, the enterprises' innovation performance, R&D internationalization is independent variable; SOE (state-owned equity) and Absorptive capacity (enterprises' absorptive capacity) are moderating variables, Controls are control variables, and ε is the random disturbance term.

The regression results are shown in Table 4. Model 1 includes only control variables. Model 2 introduces the independent variable R&D internationalization, with a coefficient of 0.438 and significant at the 1% level, indicating that enterprises' R&D internationalization positively promotes the improvement of innovation performance. Hypothesis 1 is verified. In model 3 and model 4, state-owned equity, absorptive capacity, and their interaction with R&D internationalization are introduced respectively to verify whether their moderating effect is valid. As can be seen from Model 3, the interaction term between R&D internationalization and state-owned equity positively promotes enterprise innovation performance, with a coefficient of 0.0149 and significant at the 5% level, indicating that state-owned equity (or SOE status) strengthens the positive effect of R&D internationalization on innovation performance. In Model 4, the coefficient of the interaction term between R&D internationalization and absorptive capacity is 0.0658, which is also significant at the 1% level, indicating that the positive effect of R&D internationalization on innovation performance is strengthened with the enhancement of the absorptive capacity of enterprises. Therefore, hypothesis 2 and hypothesis 3 are supported. Model 5 includes all of the variables, and the results are basically consistent with the first four models, that is, the enterprise R&D internationalization has a positive influence on innovation performance, the interaction items of state-owned equity and R&D internationalization, absorptive capacity and R&D internationalization also have a positive impact on innovation performance. Consequently, hypothesis 1, hypothesis 2, and hypothesis 3 are confirmed again.

Table 4. Regression results of main and moderating effects

	DV=Patent				
	Model 1	Model 2	Model 3	Model 4	Model 5
ROA	-0.520***	-0.469***	-0.428***	-0.239***	-0.213**
	(-7.88)	(-7.09)	(-6.41)	(-3.35)	(-2.98)
Age	-0.459***	-0.607***	-0.609***	-0.714***	-0.713***
	(-6.70)	(-8.81)	(-8.86)	(-10.19)	(-10.21)
Size	0.371***	0.327***	0.340***	0.411***	0.419***
	(18.04)	(15.90)	(16.46)	(19.38)	(19.69)
Input	0.631***	0.572***	0.537***	0.470***	0.449***
	(37.66)	(33.88)	(31.76)	(26.56)	(25.39)
R&D internationalization		0.438***	0.394***	0.451***	0.420***
		(19.36)	(17.17)	(19.53)	(18.09)
SOE			0.467***		0.422***
			(13.90)		(12.53)
Absorptive capacity				2.708***	2.677***
				(16.17)	(15.87)
R&D internationalization *SOE			0.0149**		0.0269***
			(1.94)		(3.25)
R&D internationalization *Absorptive capacity				0.0658***	0.0230**
				(6.89)	(2.21)
Year	yes	yes	yes	yes	yes
N	1456	1456	1456	1456	1456
Log likelihood	-10598.315	-10406.705	-10260.357	-10260.425	-10133.774
Wald chi2	7740.36	7984.38	8070.22	8254.51	8372.42
Prob>chi2	0.000	0.000	0.000	0.000	0.000

Note: *t* statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Fig. 2a and 2b more intuitively show the moderating effect of state-owned equity and absorptive capacity on the relationship between R&D internationalization and innovation performance.

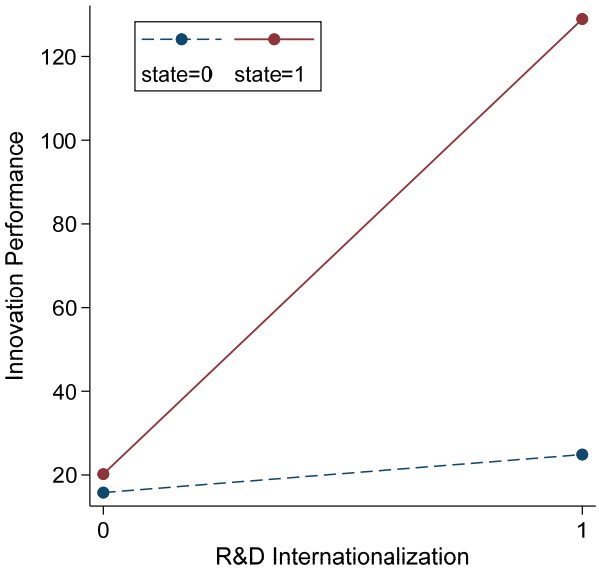

Fig. 2a Moderating effect of State-owned equity

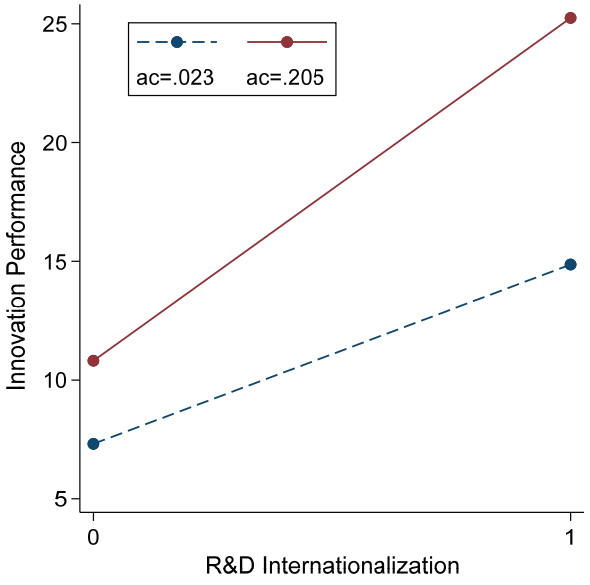

Fig. 2b Moderating effect of Absorptive capacity

4.3. Robustness test

In order to test the robustness of the empirical results, the measurement method of the dependent variable is altered in this paper. There are some ways to measure the innovation performance, such as the output of new products (Tsai, 2001; Lööf, 2009; Arvanitis & Hollenstein, 2011), and the total amount of patent applications (Iwasa & Odagiri, 2004; Penner-hahn & Shaver, 2005; Wu et al., 2016). This paper adopts the total amount of enterprise' patent applications to measure innovation performance. In terms of patent specific classification, invention patents have more technical content and better reflect innovation than design patents and utility model patents (Xia Lijuan et al., 2017; He Ai & Zhong Jingwen, 2018). Therefore, the measurement method of innovation performance is replaced by the total amount of invention patent applications. In addition, to reduce the potential endogenous bias, this paper employs independent variable, moderating variables and control variables with a one-year lag. The Poisson fixed-effect models are as follows:

$$\text{Patent}_{it} = \beta_0 + \beta_1 \text{R\&D internationalization}_{it-1} + \beta_2 \text{SOE}_{it-1} + \beta_3 \text{Absorptive capacity}_{it-1} + \beta_4 \text{R\&D internationalization}_{it-1} \times \text{SOE}_{it-1} + \beta_5 \text{R\&D internationalization}_{it-1} \times \text{Absorptive capacity}_{it-1} + \sum \beta_k \text{Controls}_{it-1} + \varepsilon_{it}$$

$$\text{Invention patent}_{it} = \beta_0 + \beta_1 \text{R\&D internationalization}_{it-1} + \beta_2 \text{SOE}_{it-1} + \beta_3 \text{Absorptive capacity}_{it-1} + \beta_4 \text{R\&D internationalization}_{it-1} \times \text{SOE}_{it-1} + \beta_5 \text{R\&D internationalization}_{it-1} \times \text{Absorptive capacity}_{it-1} + \sum \beta_k \text{Controls}_{it-1} + \varepsilon_{it}$$

The results of the robustness test are shown in Table 5. The dependent variable of Model 6-9 is patent, and the other variables lag by one year. The coefficient of independent variable R&D internationalization in Model 6 is 0.321 and significant at the 1% level. Model 7 and Model 8 investigated the moderating effect of the two moderating variables once more. The coefficient of the interaction term between R&D internationalization and state-owned equity is 0.0989, and it is significant at the 1% level, as is the coefficient of the interaction term between R&D internationalization and absorptive capacity, which is 0.167. The dependent variable of Model 10-13 is invention patent, and the other variables lag by one year. The coefficient of R&D internationalization in Model 10 is 0.292 and significant at the 1% level. Model 11 reveals that the coefficient of the interaction term between R&D internationalization and state-owned equity is 0.0953 and significant at the 1% level, while Model 12 reveals that the coefficient of the interaction term between R&D internationalization and absorptive capacity

is 0.146, which is also significant at the 1% level. This means that all hypothesis have been confirmed. The regression results of all variables and interaction terms are represented by Model 9 and Model 13. It can be seen that R&D internationalization is significantly positively correlated with innovation performance, and that state-owned equity and absorptive capacity moderate the relationship significantly positively. On the whole, the results of the robustness test are essentially consistent with the results of the benchmark regression, indicating that the conclusions of this paper are robust.

Table 5. Robustness test

	DV=Patent				DV=Invention patent			
	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
ROA	0.349***	0.406***	0.660***	0.719***	0.697***	0.743***	0.931***	0.958***
	(3.77)	(4.35)	(6.74)	(7.31)	(5.47)	(5.80)	(6.97)	(7.17)
Age	-0.779***	-0.689***	-0.840***	-0.795***	-0.568***	-0.514***	-0.648***	-0.610***
	(-10.14)	(-9.05)	(-10.84)	(-10.30)	(-5.57)	(-5.08)	(-6.31)	(-5.96)
Size	0.373***	0.353***	0.450***	0.435***	0.325***	0.322***	0.385***	0.380***
	(17.94)	(16.92)	(20.94)	(20.15)	(11.55)	(11.37)	(13.17)	(12.94)
Input	0.405***	0.363***	0.289***	0.272***	0.502***	0.461***	0.416***	0.398***
	(24.25)	(21.87)	(16.56)	(15.70)	(22.60)	(20.71)	(17.69)	(16.93)
R&D	0.321***	0.211***	0.274***	0.221***	0.292***	0.215***	0.234***	0.210***
internationalization	(15.01)	(9.57)	(12.56)	(10.00)	(10.37)	(7.44)	(8.11)	(7.21)
SOE		0.386***		0.328***		0.231***		0.176**
		(9.56)		(7.76)		(4.45)		(3.27)
Absorptive capacity			2.099***	2.490***			1.121***	1.459***
			(11.70)	(13.86)			(4.81)	(6.22)

R&D internationalization* SOE		0.0989*** (13.11)		0.0906*** (10.80)		0.0953*** (9.08)		0.0804*** (6.84)
R&D internationalization* Absorptive capacity			0.167*** (18.18)	0.0837*** (7.74)			0.146*** (11.84)	0.0804*** (5.50)
Year	yes	yes	yes	yes	yes	yes	yes	yes
N	1286	1286	1286	1286	1276	1276	1276	1276
Log likelihood	-9867.6477	-9682.2025	-9661.9202	-9562.398	-6551.2356	-6474.6463	-6476.7904	-6442.1054
Wald chi2	5979.26	6161.22	6297.18	6352.50	4186.28	4288.76	4303.26	4333.57
Prob>chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: *t* statistics in parentheses

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

5. Conclusion

Taking the listed companies in Chinese information technology industry from 2009 to 2020 as research samples, this paper tests the relationship between R&D internationalization and innovation performance of EMNCs, and further discusses the moderating effects of state-owned equity and absorptive capacity on the relationship, and draws the following conclusions: First, R&D internationalization significantly improves the innovation performance of enterprises in Chinese information technology industry. Therefore, as the "latecomer" in R&D and innovation, EMNCs need to learn and accumulate richer operation experience in R&D internationalization, absorb and integrate advanced heterogeneous knowledge and technology by investing in R&D in the host countries with more resource endowment and advanced technology. Finally, these innovation resources obtained in the process of R&D internationalization will be reversely transferred to the parent company, to improve the innovation ability and performance of the parent company.

Second, enterprises' state-owned equity significantly positively moderates the relationship between R&D internationalization and innovation performance. As a socialist country with Chinese characteristics, China has established a socialist market economy system, optimizes the allocation of resources under state macro-control, and gives full play to the decisive role of the socialist market economy in resource allocation. Therefore, compared with private and foreign-funded enterprises, SOEs with large state-owned equity inherently carry more social resources, such as technical information sharing, innovation resources support, and investment guarantee. These social resources provided by the home government play an important role in their R&D internationalization activities, and accelerate the improvement of their innovation performance. As for non-SOEs, also can increase the state-owned equity, or establish proper political connections with the government through their senior executives taking social positions (representatives of the National People's Congress at all levels, members of the Chinese People's Political Consultative Conference, etc.) to obtain social resources from the home government. However, it should be noted that enterprises should properly handle the relationship between political behavior and market behavior while using political connection to obtain government resources and supports to promote R&D internationalization, to avoid excessive government participation and interference in enterprises' operation and management.

Thirdly, the enterprises' absorptive capacity significantly positively moderates the

relationship between R&D internationalization and innovation performance. The stronger the absorptive capacity of the enterprise is, the more it can absorb and transform from external knowledge. Therefore, as a “follower” and “learner”, MNCs in emerging economies should enhance their absorptive capacity by increasing R&D investment and expanding the scale of R&D personnel, to better identify, acquire, absorb, and transform external advanced knowledge and technology in the process of R&D internationalization, and ultimately promote the improvement of enterprises’ innovation ability and performance.

5.1. Contributions

First, this paper focuses on the research on R&D internationalization and innovation performance of enterprises in emerging economies, which is a useful supplement and enrichment to the existing theoretical research on R&D internationalization and innovation performance of MNCs mainly focusing on developed countries. Previous studies mostly focused on the R&D internationalization behavior of technology transformation and application of enterprises in developed countries. But as the “latecomer” of technological innovation, MNCs in emerging economies carry out international R&D activities to make full use of the international market for knowledge and technology learning, realize technology catch-up, and cope with the fierce global market competition. Therefore, their R&D internationalization behavior presents the obvious characteristics of technology seeking and acquisition, different from those in developed countries. This paper, taking Chinese enterprises as the research sample, further enriches and improves the theoretical research on R&D internationalization and innovation performance of MNCs.

Second, from the perspective of social resources in the home country, this paper explores the role mechanism of state-owned equity in the relationship between R&D internationalization and innovation performance of EMNCs, expanding the research boundary of R&D internationalization and innovation in the context of socialist market economy with Chinese characteristics. Existing relevant researches are generally based on the perspective of enterprises’ internal resources and host country resources, to explore the moderating effect of enterprises’ overseas expansion experience, R&D investment, or the development degree of the host country on the relationship between R&D internationalization and parent company’s innovation performance. Therefore, this paper studies the effect of state-owned equity from the

perspective of social resources in the enterprises' home country, which enriches the micro institutional perspective and situational factor research of MNCs' R&D internationalization and innovation performance.

Thirdly, this paper studies the moderating mechanism of absorptive capacity on the relationship between R&D internationalization and innovation performance, expanding the research boundary of R&D internationalization and innovation. Although existing studies have focused on the influence mechanism of reverse knowledge transfer on the relationship between R&D internationalization and innovation performance, few studies have deeply discussed the impact of the absorptive capacity of MNCs in emerging economies from this perspective. Considering that MNCs with stronger absorptive capacity can absorb and transform more effective knowledge in R&D internationalization activities under similar conditions, this paper takes absorptive capacity into the research framework and explores its moderating effect, providing a new perspective for the research on R&D internationalization and innovation performance of MNCs.

5.2. Limitations and future research

Due to the limitation of the availability of data related to the R&D internationalization of Chinese enterprises, this paper inevitably has deficiencies. As for the independent variable R&D internationalization, this paper uses a binary method to measure whether enterprises have carried out R&D internationalization behavior in the current year. However, this measurement method is relatively simple and rough, and it is impossible to further study the impact of R&D internationalization's intensity and diversity on innovation performance. As the relevant data on R&D internationalization activities of Chinese enterprises become more and more complete and open, the follow-up research can be carried out from the two dimensions of R&D internationalization's intensity and diversity. In addition, although this paper studies the role mechanism of state-owned equity in the relationship between R&D internationalization and innovation performance, the exploration from the perspective of home country's social resources is not comprehensive. Subsequent research can continue to explore the influencing mechanism of social resources in the home country from government subsidies and executives' political connections.

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연구 개발의 국제화 및 혁신성과: 중국 기업을 중심으로

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요 약

연구개발의 국제화 과정에서 중국 기업을 비롯한 신흥시장 기업들은 혁신 능력과 성과를 높이기 위해 해외에서 선진적인 지식과 기술 자원을 찾는다. 본 연구는 2009년부터 2020년까지 중국 정보기술산업 상장기업을 표본으로 삼아 연구개발의 국제화가 혁신성과에 미치는 영향을 검증하고, 국유지분과 흡수능력이 각각 '연구개발의 국제화'와 '혁신성과' 양자 간의 관계에 대한 조절효과를 검토하였다. 실증결과에 의하면, 연구개발의 국제화가 기업의 혁신성과에 긍정적인 영향을 미치며, 국유지분과 흡수능력이 모두 양자 간의 관계에 긍정적인 조절 역할을 한다.

따라서 이는 첫째, 연구개발의 국제화 과정에서 신흥 다국적기업들이 국유지분의 비율을 높이거나 정치적 관계를 맺어 모국 정부로부터 지원과 서비스를 얻을 수 있고, 둘째, 연구개발 투자를 늘림으로써 해외에서 선진 지식과 기술을 흡수하여 전환함으로써 기업의 혁신성과를 향상시킬 수 있음을 시사한다.

핵심주제어: 연구개발의 국제화, 혁신성과, 국유지분, 흡수능력
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