

Research on Overseas Technology Mergers and Acquisitions Based on Big Data Mining Technology

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Abstract. The dual ability of enterprises is the core competitiveness of enterprises. Faced with the weak innovation ability of enterprises, many enterprises have carried out overseas technology mergers and acquisitions to improve their technical ability. Based on CiteSpace visualization software, this paper makes a bibliometric analysis on the research results of overseas technology M&A, and carries out text mining on the influencing factors of overseas technology M&A according to the keyword co-occurrence network diagram and time zone diagram. It is found that overseas technology M&A improves the dual innovation ability of enterprises through the direct acquisition of technology and knowledge. However, the effect of the improvement of dual innovation capability on performance is still constrained by resources and institutions. Further, taking the overseas technology M&A events of Chinese listed companies as samples, this paper examines the influence of dual innovation capability on the innovation performance of enterprises and the moderating effects of institutional environment, cultural distance, redundant resources and corporate ownership in the process of overseas technology M&A. The results show that institutional environment, cultural distance, redundant resources and firm ownership all play a positive moderating role in the process of promoting the innovation performance of firms with dual competences.

Keywords: Big data mining technology · Enterprise dual capability · Institutional environment · Cultural distance · Redundant resources · Enterprise ownership

1 Introduction

Big data mining technology can quantitatively and qualitatively analyze the status and hot spots of a research field. Through network information extraction, bibliometric analysis, visualization technology and regression analysis [1], it can more quickly and vividly grasp the relationship and evolution of knowledge structure in related fields. Therefore, scholars often use it to explore research trends and development trends of a field.

Technological innovation is an effective means for enterprises to maintain their competitiveness, and it is also a way for enterprises to seek for more profits in different markets. Exploitative innovation enables enterprises to use external knowledge, skills



Fig. 1. Literature screening process

and all their own knowledge to innovate, so as to consolidate the existing market and maintain their own competitiveness. Exploratory innovation can enable enterprises to gain first-mover advantage in new markets, occupy the market earlier and gain more monopoly profits [2]. Therefore, in order to improve their own creativity, enterprises will, on the one hand, introduce some R&D personnel with new technologies to carry out internal innovation; on the other hand, enterprises will carry out overseas technology mergers and acquisitions with the goal of obtaining high-tech technologies from the other side.

Based on the above analysis, this paper uses CiteSpace visualization software to perform literature measurement on the research results of overseas technology M&A in web of science, excavates the factors that influence the innovation performance of the dual-innovation capability in overseas technology M&A, and then makes an empirical test by taking the overseas technology M&A events of Chinese listed companies as samples.

2 Data Sources and Research Methods

2.1 Data Sources

In order to make the data scientific and comprehensive, SSCI and SCI-Expended of web of science (core collection) are selected as data sources in this paper. After filtering according to the following steps, 422 effective documents are finally obtained (See Fig. 1).

2.2 Literature Metrology

Bibliometrics can be used to quantitatively and qualitatively analyze the status and research hotspots of a discipline or research field. Through papers, citations and text data, bibliometrics can obtain the connection between keywords, citations, authors and other information, and grasp the relationship and evolution of knowledge structure in

related fields more vividly through visualization [3]. Therefore, scholars often use it to explore research trends and developments in a field. In this paper, CiteSpace visualization software is used to perform literature measurement on the research results of overseas technology M&A in web of science, and to explore the factors that influence the innovation performance of overseas technology M&A with dual innovation capability.

3 Results and Analysis

3.1 Bibliometric Analysis

(1) Keyword co-occurrence network

Keywords can accurately express the core content and essence of a paper, keyword co-occurrence analysis can be used to analyze the development trend and hot spots of a research field. Citespace was used for keyword co-occurrence analysis of 422 papers, as shown in Fig. 2. In the figure, the size of the circle represents the keyword frequency, and the larger the circle, the higher the keyword frequency and the more important the word. The centrality of a keyword measures the importance of its position by counting the number of times the keyword is combined with other keywords.

As can be seen from Fig. 2, in addition to merger, acquision, mergers and acquisition, High frequency words such as technology, innovation, performance, productivity and market are the focus of scholars in this field. Technology merger and acquisition refers to a kind of merger and acquisition activity that obtains technical resources through merger and acquisition to fill and update the lack of knowledge [4]. Overseas technology M&A is an important way for enterprises to use external technology to eliminate the uncertainty and high cost of research and development and realize the transition growth of their own technology level [5]. The effect of overseas technology M&A is the focus of many scholars. Some scholars believe that overseas technology M&A faces huge cost and absorption dilemma, and cannot improve innovation performance. However, some scholars believe that overseas technology M&A can directly obtain the technical



Fig. 2. Keyword co-occurrence network

resources of the target side and improve the bi-valent innovation ability brought by the expansion of knowledge base and technical resources. Some scholars pay more attention to the factors affecting the effect of technology M&A process, mainly focusing on the influence of the enterprise's own resource base and institutional environment, including enterprise dynamic capacity, absorptive capacity, information, knowledge spillover, complexity, etc. [6]. Although overseas technology M&A can directly improve the target enterprise's technology and knowledge to achieve the direct improvement of the dual innovation ability, there are different views on the impact of technology M&A on innovation performance.

(2) Key words evolution trend

By dividing keywords according to different years, the evolution of keywords can be obtained, so as to analyze the evolution of research hotspots in this field. In this paper, CiteSpace is used to make time zone chart for keywords, and Fig. 3 is obtained. The background bar is the year, the size of the circle represents the frequency of keywords, and the line represents the connection between keywords. As can be seen from Fig. 3, in early studies, scholars paid more attention to the impact of overseas technology M&A on enterprises' competitive advantage, market size and performance, as well as the impact of experience, ability and knowledge on the effect of technology M&A. With the increasing number of overseas technology M&A events, research has turned to empirical research on technology M&A, focusing on the knowledge spillover and value creation brought by overseas technology M&A. In recent years, with the refinement and deepening of research, scholars have begun to pay attention to the process of M&A. Overseas technology merger and acquisition refers to the technology merger and acquisition behavior of domestic enterprises aiming at obtaining advanced R&D resources and key knowledge base of foreign enterprises [7]. Through overseas technology merger and acquisition, enterprises can transform external technology transactions into internal technology learning, so as to eliminate external uncertainties and realize capability transition and sustainable innovation [5]. From the perspective of influencing factors, M&A performance will be directly affected by technological innovation ability, as well as moderated by resource factors such as cultural distance and redundant resources



Fig. 3. Time zone diagram

[8]. Although overseas technology M&A will bring external technical resources, the improvement of enterprise's technical capability also requires enterprises to internalize these scarce technical resources into their own technical capabilities. Cultural distance and redundant resources will limit the process of M&A. From the perspective of the effect of M&A, emerging enterprises acquire advanced technologies through overseas technology M&A and significantly improve their operational performance. However, due to the restriction of institutional environment and enterprise ownership, the acquirer fails to achieve smooth transfer and transformation of technical knowledge, and even fails to improve the capability structure due to local protectionism and other administrative intervention.

3.2 Empirical Analysis

Based on the above analysis, it is found that although overseas technology M&A improves the bi-valent innovation ability of enterprises through the direct acquisition of technology and knowledge, the impact of the improvement of bi-valent innovation ability on performance is still subject to the dual constraints of resources and institutions. In this paper, we take the overseas technology M&A enterprises in China from 2007 to 2021 as samples, use M&A announcements to screen the M&A targets in order to obtain the advanced technology, patents or corresponding R&D personnel of the target party, and empiricallytest the influence of the dual capability on the innovation performance of the enterprise, and the moderating role of the enterprise resource acquisition ability and institutional environment. The sources and measures of variables are shown in Table 1.

(1) Variable selection and measurement

(2) Regression analysis

Based on the research hypothesis and data characteristics of this paper, the following model is constructed to verify the research hypothesis:

$$PA = \beta_0 + \beta_1 \text{control} + \beta_2 LA + \beta_3 TA + \varepsilon$$
(1)

$$PA = \beta_0 + \beta_1 \text{control} + \beta_2 LA + \beta_3 TA + \beta_4 a djust + \beta_5 LA * a djust + \beta_6 TA * a djust + \varepsilon$$
(2)

Model (1) examines the impact of exploitative innovation capability and exploratory innovation capability on innovation performance. PA is the innovation performance of the enterprise in the year after merger, control is the control variable, LA is the utilization capability of the enterprise, and TA is the exploration capability of the enterprise. On the basis of Model (1), institutional environment, cultural distance, corporate ownership and redundant resources are added as moderating variables to test the moderating effects of institutional environment and resource acquisition ability. Adjust represents four moderating variables, namely institutional environment, cultural distance, corporate ownership and redundant resources, and ε is the residual term vector.

(3) Empirical results

In Table 2, from model 2, we can see that exploitative innovation capability and exploratory innovation capability have a significant positive effect on enterprise innovation performance ($\beta 1 = 0.634$, p < 0.01; $\beta 2 = 0.171$, p < 0.1). On the basis of model

	Variable	measurement		
Dependent variable	Innovation performance (PA)	Number of patents filed by enterprises		
Independent variable	Development innovation ability (LA) Exploratory innovation ability (TA)	The enterprise's invention patent yu for this year f is compared with the previous year. If the patent involves a field that was involved in the previous year, the development capability is 1 and the exploration capability is 0. Otherwise, the development capability is 0 and the exploration capability is 1. The total score is used to measure the development ability and ovelopment ability and		
Regulating variables	Redundant resource (RZ)	The number of R&D personnel owned by the main M&A firm during the M&A year		
	Enterprise ownership (OS)	Enterprises with more than 50% state ownership are classified as state-owned enterprises, measured by the number 1, while other types of enterprises are classified as non-state-owned enterprises, measured by the number 2		
	Institutional environment (IE)	Use the survey-based city intellectual property index published by the Academy of Social Sciences (CASS)		
	Cultural distance (CD)	Based on the practice of Killian J. McCarthy et al. [9], the world is divided into North America, Europe and Asia Pacific systems according to three different governance traditions and social cultures. We believe that cultural distance is low in one system and high in different systems. North America is represented by a 1, Europe by a 2, and other regions by a 3		

Table 1. Sources and measures of variab

(continued)

	Variable	measurement	
Control variables	Age	The time from the inception of the enterprise to the present	
	Size	Measured by an enterprise's annual operating revenue	
	Difference	Use 1 for manufacturing, 2 for electronics and information, or 3 for other industries	

Table 1. (continued)

Table 2. Empirical results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	0.010	0.258	-10.034	-10.822	-40.103*	-40.331
Age	0.016*	0.003	0.004	0.004	0.004	0.005
Difference	-0.046	0.028	0.004	-0.027	-0.002	-0.022
Size	0.123**	0.047	0.039	0.042	0.039	0.039
LA		0.634***	0.601***	0.587***	0.571***	0.581***
TA		0.171*	0.157**	0.147*	0.147**	0.145**
RZ			0.040**	0.171*	0.099^{*}	0.134**
IE			20.263^{*}	0.761**	10.533*	10.409*
OS			0.170**	0.555**	0.964**	10.129**
CD			0.032*	-0.119**	-0.682***	0.578^{**}
LA*RZ				0.057^{*}		0.140**
LA*IE				0.839^{*}		10.160^{*}
LA*OS				0.273*		0.129**
LA*CD				0.061***		0.255***
TA*RZ					0.016*	0.121**
TA*IE					0.230**	0.755*
TA*OS					0.501***	0.413**
TA*CD					0.387***	0.571***
R2	0.101	0.663	0.678	0.694	0.732	0.710
R2_a	0.065	0.642	0.644	0.646	0.690	0.760

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

2, four moderating variables including redundant resources, institutional environment, corporate ownership and cultural distance are added to model 3 for regression analysis. The results show that the influence of development ability and exploration ability on innovation performance is weakened after the addition of the moderating variables. However, the effects were significant ($\beta 1 = 0.601$, p < 0.01, $\beta 2 = 0.157$, p < 0.05); Model 4 is based on model 3, adding the cross terms of development ability and regulatory variables. The data results show that the cross terms of development ability, redundant resources, institutional environment, enterprise ownership and cultural distance are significantly positive ($\beta 1 = 0.057$, p < 0.1, $\beta 2 = 0.839$, p < 0.1; $\beta 3 = 0.273$, p $< 0.1; \beta 4 = 0.061, p < 0.01)$, indicating that the four moderating variables have significant positive effects on the relationship between development capability and innovation performance. Model 5 is based on model 3, adding the cross terms of exploration ability and moderating variables. The results show that the cross terms of exploration ability and redundant resources, institutional environment, enterprise ownership and cultural distance are also significantly positive ($\beta 1 = 0.016$, p < 0.1, $\beta 2 = 0.230$, p < 0.05; $\beta 3$ = 0.501, p < 0.01; $\beta 4 = 0.387$, p < 0.01), indicating that the four moderating variables have a significant positive effect on the relationship between exploration ability and innovation performance.

(4) Adjustment effect test

In order to show the regulating effect of redundant resources, institutional environment, corporate ownership and cultural distance more directly, we draw the corresponding interactive effect graph. As shown in Figs. 4 and 5, the moderating effect of redundant resources on the relationship between development capability or exploration capability and firm performance is demonstrated. Whether the degree of redundant resources is high or low, the slope is positive. Development ability and exploration ability have positive incentive effect on enterprise performance. Figures 6 and 7 show that enterprise ownership has a significant positive adjustment on the relationship between development ability, exploration ability and enterprise performance. This indicates that the smaller the resource constraints an enterprise faces, the stronger the promotion effect of its dual innovation ability on innovation performance.



Fig. 4. Regulation of RZ on LA











Fig. 7. Regulation of OS on TA

Figures 8 and 9 show the moderating effect of institutional environment on the relationship between development ability or exploration ability and enterprise performance. The moderating effect of intellectual property protection index on the relationship

between development ability and exploration ability and enterprise performance is different. In the region with higher intellectual property protection index, local enterprises' development ability and exploration ability have stronger positive incentive effect on enterprise performance. The moderating effect is more obvious in exploratory innovation ability. Figures 10 and 11 show that the nature of cultural distance largely moderates the impact of development capability and exploration capability on enterprise innovation performance one year later. No matter where the target is located, cultural distance has a positive moderating effect on the relationship between development capability, exploration capability and enterprise performance. This shows that stable political environment and different cultural environment play a non-negligible role in the innovation of enterprises.



Fig. 9. Regulation of IE on TA







Fig. 11. Regulation of CD on TA

4 Result Discussion

(1) Literature data mining

Based on big data mining technology, this paper carries out literature measurement on overseas technology M&A related research in Web of science. The keyword cooccurrence network diagram and keyword time zone diagram show that the resource base and institutional environment of an enterprise are important factors for the effect of M&A. From the evolution trend of keywords in recent years, the influence of M&A on bi-innovation and the influence of bi-innovation capability on innovation performance have become the focus of overseas technology M&A.

(2) Discussion of empirical results

The above results show that the improvement of bivariate capability after M&A plays a significant role in promoting the innovation performance of enterprises, and the resource acquisition capability of enterprises plays a positive moderating role in the improvement of bivariate capability after M&A. Moreover, stable and powerful institutional environment and diversified cultural environment will enhance the effect of the improvement of the bivariate capability on the innovation performance of enterprises.

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