Impact of Enterprise Innovation Capability on Mergers and Acquisitions Performance

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Corporate mergers and acquisitions are beneficial for enhancing competitiveness, promoting industrial upgrading, and expanding market share. Since the 18th National Congress of the Communist Party of China, the country has attached great importance to innovation and focused on promoting innovation, placing it at the core of strategic deployment. It can be seen that enhancing innovation capability is particularly important for enterprises. Based on this background, analyzing the relationship between corporate innovation capability and merger and acquisition performance has important academic research significance.

This article selects the corporate mergers and acquisitions events of listed companies from 2015 to 2019 as the research object, and empirically tests the impact of corporate innovation capability on corporate merger and acquisition performance through regression analysis. The empirical results show that: (1) the innovation capability of enterprises has a positive promoting effect on the performance of corporate mergers and acquisitions; (2) Both manufacturing and non manufacturing

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enterprises show a significant positive correlation between their innovation capabilities and M&A performance; (3) There is a significant positive correlation between the innovation capability of enterprises that do not involve major asset restructuring and their M&A performance; (4) Geographical regions can affect the relationship between a company's innovation capability and its merger and acquisition performance.

1. INTRODUCTION

Mergers and Acquisitions (M&A) denote the merging or acquisition of two or more companies. In today's globalized and rapidly changing business environment, companies across various industries pursue strategic growth through mergers and acquisitions to secure more resources, expand market share, and enhance core competitiveness. In the pharmaceutical industry, Pfizer's acquisition of Allergan Pharmaceuticals, for instance, created the world's largest pharmaceutical company, showcasing strategic expansion and diversification; In the technology sector, Alphabet, a subsidiary of Google, has conducted numerous mergers and acquisitions over the past few years, underscoring the importance of acquiring new technologies and innovation capabilities through these activities; In the energy industry, oil and gas giant BP's acquisition of solar project developer Lightsource serves as an example of how mergers and acquisitions facilitate the energy transition. Faced with intensifying market competition and a continuously evolving economic landscape, an increasing number of companies are engaging in mergers and acquisitions. According to the Guotai An database, the number of mergers and acquisitions in the industry from 2015 to 2019 was 5,189, 5,294, 4,750, 5,189, and 5,689 respectively, showing an overall upward trend.

Concurrently, the government has implemented a suite of policies aimed at fostering innovation within enterprises, offering guidance for their strategic growth. The 2016 13th Five-Year Plan introduced the principles of "innovation, coordination, sustainability, openness, and shared development" to stimulate innovation-driven progress. The 2021 14th Five-Year Plan maintains a focus on innovation-driven development, underscoring its central role in modernization efforts and advocating a shift from a traditional, resource- and labor-dependent economic model to an innovation-driven economy, thereby encouraging enterprises to bolster their innovation capabilities. In 2022, the Ministry of Science and Technology and the Ministry of Finance released the "Action Plan for Enhancing Enterprise Technological Innovation Capability (2022-2023)", featuring ten specific initiatives aimed at guiding and assisting diverse enterprises in embracing technological innovation as their core competency. These policies demonstrate that innovation serves not only as an engine for sustained economic growth but also as a crucial factor for enterprises to strengthen their core competitive edge. Enhancing enterprises' capacity for independent innovation is essential for fundamentally advancing the country's sustainable competitiveness.

At present, many scholars in the Chinese academic community have studied the relationship between innovation capability and merger and acquisition performance. Innovation can help enterprises achieve synergies. Therefore, by reviewing literature, proposing hypotheses, and using enterprise innovation output as an indicator to measure enterprise innovation capability, we analyze the inherent impact mechanism between innovation capability and merger and acquisition performance, and then make recommendations. This article takes 2245 merger and acquisition events of Chinese listed companies from 2015 to 2019 as sample data, establishes a regression model, and further analyzes them from three dimensions: industry category, geographical region, and major asset restructuring, in order to explore the inherent logical relationship between the two.

2. LITERATURE REVIEW

2.1 literature Review on the Measurement Methods of Innovation Capability

Austrian economist Joseph Schumpeter was the earliest proposer of the concept of "innovation". In his "Theory of Economic Development", Schumpeter [1] pointed out that innovation activity is the improvement of existing production factors and conditions, achieving new effects by

establishing new production functions, and the growth of capitalist economy cannot be separated from innovation activity. Nowadays, many scholars also admit that innovation capability is one of the core competitiveness of enterprises. There are usually two perspectives for measuring innovation capability.

The first type is measured by innovation investment, which includes technological innovation investment and non-technical innovation investment, and can to some extent reflect the enthusiasm of enterprises for innovation. In the selection of measurement indicators, some scholars choose to invest in R&D funds in the current year [2], while others choose to invest in R&D personnel, specifically referring to the proportion of R&D personnel to the total number of employees in the current year [3]. However, in the existing literature in the past five years, most scholars use the relative indicator of the proportion of R&D expenses to operating income in the current year [4,5,6].

The second type is measured by innovation output, usually using the number of patent applications as a measurement indicator. Due to the certain risks involved in the R&D process, foreign scholars Cornaggia et al. [7] also pointed out in their research that innovation output can more accurately reflect the level of innovation capability of a region or a company over a certain period of time than R&D investment. Song [8] pointed out in his study on the impact of innovation capability of listed companies on corporate merger and acquisition performance that using innovation output to measure corporate innovation capability has strong universality. Although some scholars use the number of patent authorizations as a measure, such as Zhang et al. [9], they believe that the number of patent authorizations can reflect the quality of patents. However, many scholars tend to use the number of patent applications as an indicator. Griliches et al. [10] showed that patents have a time lag from application to authorization, and the number of patent authorizations cannot reflect a company's innovation capability in a timely manner. Liu and Yang [11] pointed out that the number of patent authorizations is influenced by many factors. In contrast, the number of patent applications can more comprehensively reflect the level of innovation, and the number of patent applications can avoid the influence of subsidy factors, which is more in line with

empirical research in the Chinese context than innovation investment.

2.2 Literature Review on Performance Measurement Methods for Mergers and Acquisitions

There are three main methods for measuring the performance of mergers and acquisitions by acquirers in existing literature: financial indicator method, event study method, and manager evaluation method.

The first type is financial indicator method. Using accounting indicators of the acquiring party after a successful merger to evaluate merger and acquisition performance, this method is mainly used to measure medium-and long-term merger and acquisition performance. Commonly used indicators include ROA, ROE, sales revenue, etc. If the merger can bring significant revenue or net profit growth to the enterprise, it indicates that the merger has had a positive impact on the enterprise's market expansion and growth. Some scholars select financial indicators from multiple dimensions of enterprise operation for measurement [12], some scholars select a single indicator [13,14], and some scholars use factor analysis to construct a new indicator system using multiple financial indicators [15]. The advantage of financial indicator method is that accounting indicators are easy to obtain and will not change with the observer's changes. It can also provide detailed financial effects generated by mergers and acquisitions events. However, the financial indicator method also has obvious drawbacks. Trahms et al. [16] pointed out that the financial indicator method may underestimate the value of intangible assets and there may also be situations where management manipulates financial indicator data. Huang [17] pointed out that the competitive environment of enterprises is becoming increasingly complex, and the use of financial indicators to measure merger and acquisition performance has certain subjectivity and incompleteness.

The second type is the event study method. The performance of mergers and acquisitions is measured by studying the stock price fluctuations of the acquiring party before and after the occurrence of the merger and acquisition event. The specific measurement indicator is the cumulative abnormal return (CAR) of the acquiring company's stock during the merger and acquisition event period. This method is mainly used to study short-term merger and acquisition

performance. The event study method is a commonly used approach, but there is still considerable controversy. Brauer and Wiersema [18] pointed out that short-term stock prices may be affected by asymmetric merger and acquisition information, which may underestimate abnormal returns. Therefore, some scholars believe that event analysis based on short-term stock prices is not suitable for studying merger and acquisition performance [19,20].

In the past 20 years, Western scholars have created the long-term event study method based on the short-term event study method to study the long-term merger and acquisition performance. The long-term event study method uses a variety of measurement indicators, including cumulative abnormal returns (CAR), monthly average returns, and buy hold abnormal returns (BHAR). Fridolfsson and Stennek [21] argue that using long-term stock prices is more suitable for measuring M&A performance than short-term stock prices, as a longer time window can exclude the impact of information leakage and M&A expectations. However, Zhang [22] summarized the support for short-term event research methods, pointing out that long-term stock prices are influenced by various events, resulting in a lack of accuracy in measuring long-term performance indicators.

The third type is manager evaluation method. Mainly within 3-5 years after the merger and acquisition event, conduct a questionnaire survey on the managers involved in the merger and acquisition. Compared with foreign scholars, there are currently few literature using this method in China, but for empirical research on non listed companies, the manager evaluation method is the only choice.

The advantage of the manager evaluation method is that it can obtain more private information that only the management team knows. Papadakis and Thanos [23] believe that the information provided by managers can provide a multidimensional understanding of the company and better evaluate its merger and acquisition performance. However, most domestic scholars have concerns about the management evaluation method, mainly due to insufficient participation in questionnaire evaluation, which has a certain degree of randomness and subjectivity.

2.3 Literature Review on the Impact of Innovation Capability on Merger and Acquisition Performance

Innovation capability can improve the performance of corporate mergers and acquisitions, and foreign scholars have conducted research on the relationship between innovation capability and corporate merger and acquisition performance. Bena and Li [24] used cases of cross-border mergers and acquisitions between 1984 and 2006 to investigate the relationship between a company's innovation activities and the incidence of mergers and acquisitions using regression models. Research has shown that technological overlap between companies involved in mergers and acquisitions has a positive impact on the incidence of mergers and acquisitions. Cheng and Yang [25] collected questionnaire survey data from 186 senior managers responsible for cross-border mergers and acquisitions from developed countries in the Yangtze River Delta region. After conducting regression analysis, they concluded that technological innovation capability is positively correlated with cross-border M&A performance. Jiang and Zhu [26] studied data from 186 Chinese manufacturing companies that initiated cross-border mergers and acquisitions between 2012 and 2017. The research results showed that there is a positive correlation between the current innovation capabilities of the acquiring companies and their decisions to engage in cross-border mergers and acquisitions.

Most domestic scholars have also reached a consistent conclusion on the relationship between corporate innovation capability and merger and acquisition performance. Chen et al. [27] conducted a study using data from 193 A-share listed companies in China in 2013 and found a positive correlation between regional innovation level and M&A performance. They found that the higher the innovation level of the acquiring and target companies in their respective regions, the better the M&A performance. Zhang and Liu [28] studied 7086 equity mergers and acquisitions of Chinese listed companies from 1998 to 2015 using event analysis method. When both the acquired company and the acquiring company have innovative capabilities, it helps to generate innovative synergies and improve long-term M&A performance. Xiao et al. [29] conducted a study on 178 high-tech listed companies that underwent merger and acquisition transactions in 2010 and 2011, and found that innovation

investment contributes to the improvement of merger and acquisition performance. The innovative capital of acquiring companies has a significant positive impact on merger and acquisition performance. Wen and Zou [30] collected the M&A events of Internet A-share listed companies as M&A companies or target companies from 2009 to 2017 as samples, and found that the innovation ability of target companies was positively related to their willingness to conduct M&A activities.

Through literature review both domestically and internationally, it has been found that a small number of scholars have come to different conclusions regarding research in this field. Federico et al. [31] found that the decrease in R&D investment by the acquiring party after a merger event did not result in a significant increase in merger performance. Zhou et al. [32] analyzed data from A-share listed companies from 2004 to 2010 and found that the impact of innovation capability on merger and acquisition performance is not significant.

3. RESEARCH DESIGN

3.1 Research Hypothesis

The 14th Five Year Plan proposes to adhere to innovation driven development, placing innovation at the core of the national development strategy, emphasizing the need to shift the economic development model from a traditional model that relies on resources and labor to an innovation driven economy, and emphasizing policy guidance in areas such as innovation, digital transformation, and intelligent manufacturing, which will have a positive driving effect on enterprise innovation. In this context, enterprises need to proactively adapt to these changes, increase investment in innovation, and continuously enhance their competitiveness.

Improving innovation capability of enterprises can reduce risks in mergers and acquisitions. The fact that the main acquirer has a significant amount of research and development achievements usually means that they have technological advantages and innovation capabilities in specific fields, which can enhance the company's innovation capabilities and market competitiveness after the merger. The acquirer usually evaluates the technological strength and innovation level of the acquired party. If the acquired party has a large number of research and development achievements, it indicates that

its technological foundation is relatively strong, which can reduce the risk of technological mismatch in the post merger integration process. Moreover, having a large number of patents can increase the negotiation and technological protection capabilities of the main acquirer in the merger and acquisition transaction, reduce technological risks, and thus improve merger and acquisition performance.

The patents and research and development achievements owned by the main acquirer can establish an excellent brand image, enhance its position and recognition in the market, which helps the main acquirer consolidate its leading position in the industry and attract more customers and partners. When the main acquirer owns patents and other research and development achievements, it reflects its competitive advantage and technological leadership in the market. This market value may attract small businesses with high innovation capabilities and high-quality talents, bringing better transaction conditions and higher investment returns to the M&A transaction, thereby improving M&A performance. Usually, having a significant amount of research and development achievements indicates to some extent that the acquiring company has strong technological integration capabilities in terms of technological innovation and research and development. According to the theory of technological innovation, the main acquirer with strong technological integration capabilities can create more innovation opportunities and synergies by combining their own technology with the technological capabilities of the target company, thereby improving merger and acquisition performance. Based on the above analysis, this article proposes hypothesis 1:

H1: Enterprise innovation capability contributes to the improvement of merger and acquisition performance.

3.2 Data

This article selects the merger and acquisition events of listed companies from January 2015 to December 2019 as the research object. There are two reasons for selecting this time period in this article: firstly, in September 2014, Premier Li Keqiang repeatedly mentioned the development concept of "mass entrepreneurship and innovation" at the meeting, and "entrepreneurship" and "innovation" often became the main topics of the State Council

executive meeting. Since 2015, enterprises have increasingly focused on cultivating their innovation capabilities, paying more attention to the impact of developing new products and the number of patents on their development. Second, the global COVID-19 broke out in 2020, which is a "black swan" event and has caused a huge impact on the enterprise economy involved in the study. Therefore, the sample time span is from 2015 to 2019.

The basic information of the merger and acquisition event in this article is sourced from the CSMAR merger and acquisition database, while the unemployment rate and per capita GDP data of various administrative regions are sourced from the RESSET national economic database. Referring to Yang's [33] research, this article screened the samples in the following order:

(1) Excluding the financial industry (as stipulated in the "Industry Classification Guidelines for Listed Companies (2012)" of the China Securities Regulatory Commission), the operating methods of this industry differ significantly from other industries;
(2) Exclude ST and * ST listed companies. To avoid the impact of financial abnormalities on the effectiveness of mergers and acquisitions;
(3) Excluding sample data of unsuccessful mergers and acquisitions, such data is not of research significance;
(4) The same company has undergone multiple mergers and acquisitions within a year, and only its first merger event is retained;
(5) Exclude companies that have not experienced any merger or acquisition events for one or more years between 2015 and 2019 to ensure data integrity;
(6) Exclude samples due to missing or abnormal relevant data to avoid bias in empirical results caused by incomplete data;
(7) Winsorize truncation was performed on all continuous variables at the 1% and 99% levels to eliminate the influence of extreme values on the research results.

Through screening, a total of 2245 merger and acquisition event samples were obtained, involving 449 companies, including 357 manufacturing companies and 92 non manufacturing companies.

3.3 Variable Definition

3.3.1 Dependent variable

This article draws on the financial indicator method adopted by scholar Liu [34] to measure the performance of corporate mergers and acquisitions. This method evaluates the changes in financial indicators of companies before and after mergers and acquisitions. This article uses the ratio of net profit to total asset balance at the end of the year for corporate mergers and acquisitions as a measure of M&A performance, with the net profit on total assets (ROA) as the dependent variable. ROA comprehensively considers the relationship between a company's net profit and total assets, reflecting the utilization efficiency and profitability of the company's assets. It can comprehensively evaluate the impact of mergers and acquisitions on the company's M&A performance, and measure whether the company can effectively use its assets to create profits after the merger. When the net profit margin of the acquiring company's total assets increases after the merger, it indicates that the M&A performance also increases.

3.3.2 Explanatory variables

This article draws on the method of Song [8] to measure the innovation capability of enterprises, using innovation output (PAT) as the explanatory variable, and its calculation formula is as follows:

$$\text{Innovation output} = \ln(\text{Number of patent applications} + 1)$$

Logarithmic transformation can help reduce the dispersion of data and the influence of extreme values. Taking the logarithm of the number of patent applications can transform the data from its normal right skewed distribution to a form closer to a normal distribution, making the data more suitable for statistical analysis. When there is no patent application, directly taking the logarithm will result in negative infinity. To avoid this situation, add 1 to the number of patent applications when calculating.

3.3.3 Control variables

In addition, this article also draws on Zhang [35], Ma [36], and others to control for the following variables:

(1) Scale of directors. The number of members on the board of directors of the acquiring party, the involvement of the company's management in the merger and acquisition transaction, and the size of the board of directors may affect the execution and decision-making process of the merger and acquisition. A larger board of directors may lead to a slow decision-making process, while a smaller board of directors may lack diversity and expertise. Therefore, this article takes the size of the acquiring party's directors as the control variable

(2) Age of the enterprise. In previous studies by scholars, the age of a company can have an impact on merger and acquisition performance, and companies at different stages will have different characteristics. In order to avoid the influence of enterprise age on the accuracy of research results, this article uses enterprise age as a control variable and subtracts the year of establishment of the enterprise from the statistical year. To standardize the indicators, the above results are taken as the logarithm.

(3) Proportion of Independent Directors (Ind). This article determines the proportion of independent directors as the ratio of the number of independent directors of the acquiring party to the total number of board members. The proportion of independent directors plays a supervisory and decision-making role in mergers and acquisitions. A higher proportion of independent directors may provide more objective and neutral opinions, increasing the transparency and effectiveness of decision-making.

(4) M&A payment method (MP). The merger and acquisition transaction adopts cash payment with a value of 1, otherwise it takes 0. The payment method for mergers and acquisitions may affect the performance of mergers and acquisitions. Different payment methods, such as cash buyouts or stock exchanges, may result in different performance outcomes. Controlling the payment methods for mergers and acquisitions can help eliminate the impact of payment methods when analyzing merger and acquisition performance.

(5) Per capita GDP (LnGDP). The per capita GDP of the province where the acquiring company is located in the year before the merger and acquisition, as well as the regional economic conditions, may affect the company's performance and merger decisions. Being in regions with higher GDP may provide more business opportunities and chances, while being in regions with lower GDP may face more challenges.

(6) Unemployment rate (UP). The unemployment rate of the province where the acquiring company is located one year before the merger may be related to factors such as job loss and employee morale. By controlling the unemployment rate, the potential impact of unemployment on merger and acquisition performance can be eliminated, and the impact of mergers and acquisitions can be better evaluated.

In order to present the meanings and specific formulas of each variable more intuitively, a series of summaries of the above variables were conducted, and the summary results are shown in Table 1:

Table 1. Variable specification

Variable label	Variable definition
ROA	Return on total assets
PAT	Innovation output
Scale	Board size
Age	Firm age
Ind	The proportion of independent directors
MP	Payment methods
LnGDP	Per capita GDP
UP	Unemployment rate

Data source：Author's manual organization

3.4 Model Establishment

To test H1, this article constructs the following regression model:

$$ROA_{i,t} = \beta_0 + \beta_1 PAT_{i,t} + \beta_2 Controls_{i,t} + \varepsilon_{i,t} \quad (1)$$

Among them, the dependent variable in the above equation is the net profit margin of total assets (ROA), and the explanatory variable is the innovation output of the enterprise (PAT). $Controls$ is the set of control variables, β_0、β_1、β_2 are regression coefficients, subscript i represents the enterprise, t represents the year, and $\varepsilon_{i,t}$ is the error term. If the regression coefficient (β_1) is positive, it indicates a positive

correlation between corporate innovation capability and merger and acquisition performance. Corporate merger and acquisition performance will increase with the increase of corporate innovation capability, and vice versa.

4. RESULTS

4.1 Descriptive Statistics

We performed Winsorize truncation on all continuous variables at the 1% and 99% levels, replacing the extreme values of the data with larger or smaller values in the data distribution to reduce the impact of extreme values on the overall data distribution and eliminate the influence of extreme values on the research results. The descriptive statistical results obtained by importing panel data of explanatory variables, dependent variables, and control variables after tail trimming into STATA are shown in Table 2.

From Table 2, it can be seen that during the sample study period, the average M&A performance of the acquiring companies was 0.023, with a median of 0.035, indicating that the asset return rate of most companies was at a relatively low level. The standard deviation is 0.092, indicating that the distribution of data is

relatively scattered and there is a certain degree of volatility, which also suggests that there are significant differences in M&A performance among different companies. The standard deviation of innovation output is 1.593, indicating a relatively dispersed distribution of data and significant differences in the innovation output data of the sample.

4.2 Correlation Analysis

In order to investigate whether variables are correlated, we conducted correlation analysis on each variable, and Table 3 shows the correlation coefficients between each variable.

From Table 3, the absolute values of the correlation coefficients of each variable are all less than 0.8, indicating that there is no serious multicollinearity problem among the variables in our model. Furthermore, according to the data provided in Table 3, it can be seen that the correlation coefficient between PAT and ROA is 0.067, showing a significant positive correlation. That is, as the innovation output of the enterprise increases, the merger and acquisition performance of the enterprise will also increase accordingly, which preliminarily verifies the hypothesis given in this paper.

Table 2. Descriptive Statistical Results

Variable label	Mean	Median	Std.Dev.	Minimum	Maximum
ROA	0.0230	0.0350	0.0920	-0.468	0.193
PAT	0.722	0	1.593	0	6.624
Scale	8.245	9	1.438	5	12
Age	17.42	17	5.069	8	31
Ind	0.382	0.375	0.0630	0.250	0.600
MP	0.932	1	0.251	0	1
LnGDP	74751	69671	28257	30217	150962
UP	2.946	2.970	0.707	1.310	4.190

Note：Author's calculation

Table 3. Correlation Analysis Results

	ROA	PAT	Scale	Age	Ind	MP	LnGDP	UP
ROA	1							
PAT	0.067***	1						
Scale	0.065***	0.0220	1					
Age	-0.056***	-0.083***	0.141***	1				
Ind	-0.0120	-0.044**	-0.503***	-0.099***	1			
MP	-0.040*	-0.046**	0.00900	0.045**	-0.038*	1		
LnGDP	-0.057***	-0.038*	-0.064***	0.00100	0.0260	0.047**	1	
UP	0.0140	-0.0160	0.0100	0.078***	-0.042**	0.0320	-0.355***	1

Note：Author's calculation

Table 4. VIF test

Variable	VIF	1/VIF
Scale	1.360	0.735
Ind	1.350	0.743
UP	1.160	0.863
LnGDP	1.160	0.863
Age	1.040	0.964
PAT	1.010	0.987
MP	1.010	0.990
Mean VIF	1.160	

Note：Author's calculation

Table 5. Regression Results

Variables	Model 1	Model 2
	ROA	ROA
PAT	0.004***	0.003***
	(3.18)	(2.76)
Scale		0.005***
		(3.37)
Age		-0.001***
		(-2.74)
Ind		0.039
		(1.09)
MP		-0.012
		(-1.52)
LnGDP		-0.000**
		(-2.07)
UP		0.001
		(0.18)
Constant	0.020***	0.002
	(9.57)	(0.06)
Observations	2,245	2,245
R-squared	0.004	0.016
F test	0.00151	5.96e-06
r2_a	0.00403	0.0131
F	10.09	5.244

*Note: ***, **, and * represent 1%, 5%, and 10% significant level，respectively，and the values in parentheses are t-values。*

In addition, in terms of controlling variables, there is a significant linear correlation between enterprise size, enterprise age, M&A payment method, per capita GDP, and M&A performance, which also indicates the necessity of adding the above control variables to the model in this paper.

4.3 VIF test

Variance Inflation Factor (VIF) is one of the most commonly used methods for testing multicollinearity. Generally, a VIF greater than 10 indicates the presence of significant collinearity issues. According to Table 4, the VIF value is 1.160, which does not exceed 10, indicating that there is no multicollinearity problem among the variables in the model, further demonstrating the reliability of the model in this paper.

4.4 Regression Analysis

Model (1) is the regression result when using enterprise innovation output as the explanatory variable, while Model (2) is the regression result when using enterprise innovation output as the explanatory variable and adding control variables. In model (1), the regression coefficient between innovation capability and corporate M&A performance is 0.004, indicating a positive correlation and significant at the 1% level. In model (2), the regression coefficient between innovation capability and corporate merger and

acquisition performance is 0.003. After adding control variables, there is still a significant positive correlation between the two at the 1% level, indicating that corporate innovation capability can significantly improve corporate innovation performance. This validates hypothesis H1 in this paper, which is relatively consistent with previous research results by most scholars [29]. When a company has high innovation capability, it may perform better in merger and acquisition activities.

Innovation capability enables enterprises to better respond to market challenges, provide unique products or services, thereby increasing market share and competitive advantage. The positive impact of innovation capability on the performance of corporate mergers and acquisitions may stem from synergies. Companies with strong innovation capability are often able to better integrate various resources and capabilities after mergers and acquisitions, achieving complementary advantages between the merging parties. This synergy effect often helps to improve the performance of corporate mergers and acquisitions. Enterprises with high innovation capabilities often demonstrate better information disclosure and transparency, providing more accurate financial and business information and reducing the occurrence of agency problems. In this way, decision-makers in corporate mergers and acquisitions can make better decisions, adjust relevant merger and acquisition strategies, reduce risks, and improve merger and acquisition performance.

According to the data in model (2), the regression coefficient between director size and corporate M&A performance is 0.005, which is significant at the 1% level, indicating that the larger the director size, the better the corporate M&A performance. The increase in the number of board members means that there are more people from different backgrounds, experiences, and professional fields participating in decision-making. This diversity can bring richer opinions and experiences, which can help to propose more comprehensive and in-depth analysis and suggestions in the merger and acquisition process, and improve the quality of merger and acquisition decisions.

The regression coefficient between enterprise age and M&A performance is -0.001, which is significant at the 1% level, indicating a significant negative correlation between enterprise age and M&A performance. Aging enterprises often face innovation bottlenecks and lack innovation capabilities for new products, technologies, and markets. In mergers and acquisitions, innovation capability is an important factor in achieving synergies and discovering new value. Older companies may have disadvantages in this regard, which is not conducive to improving merger and acquisition performance. In addition, elderly enterprises may also find it difficult to quickly adjust resources due to historical reasons or outdated management, thereby affecting merger and acquisition performance.

The regression coefficient between per capita GDP and M&A performance is -1.53E-07, which approaches 0 and shows a significant negative correlation at the 5% significance level. A lower per capita GDP may indicate a relatively backward market environment, limited resources, or a relatively small market size in the region. Mergers and acquisitions by acquiring companies in such a market environment often face more challenges.

4.5 Robust Test

In order to further ensure the robustness of the model and the accuracy of the regression results, a robustness test was conducted on the regression model. This article uses the method of replacing the dependent variable to test the robustness of the research hypothesis.

Return on equity (ROE) is an important indicator for evaluating the performance of corporate mergers and acquisitions. After the merger, it can provide key information about the overall financial health of the enterprise. We replaced ROA with ROE as the dependent variable for regression to test the robustness of the model. The regression results are shown in Table 6.

According to Table 6, the regression coefficient between innovation capability and return on equity is 0.009, indicating that the two are still positively correlated and significant at the 1% level, which is not significantly different from the results with return on equity (ROA) as the dependent variable. Therefore, the conclusion of this article is robust.

Table 6. Results

Variables	Model 3	Model 4
	ROE	ROE
PAT	0.010***	0.009***
	(3.48)	(3.17)
Scale		0.014***
		(3.78)
Age		-0.002*
		(-1.85)
Ind		0.152*
		(1.82)
MP		-0.022
		(-1.19)
LnGDP		-0.000**
		(-2.21)
UP		-0.002
		(-0.25)
Constant	0.019***	-0.070
	(3.79)	(-1.07)
Observations	2,245	2,245
R-squared	0.005	0.016
F test	0.000504	4.86e-06
r2_a	0.00494	0.0133
F	12.14	5.312

*Note: ***, **, and * represent 1%, 5%, and 10% significant level，respectively，and the values in parentheses are t-values*

5. FURTHER ANALYSIS

5.1 Industry Category Analysis

The industry type of the acquiring company is one of the factors that affect corporate mergers and acquisitions. This article divides the industry types of listed companies from January 2015 to December 2019 into manufacturing and non manufacturing industries.

In terms of technological characteristics and innovation needs, manufacturing usually involves technical fields such as product design and process manufacturing, and its innovation focus mainly lies in product research and development, process improvement, etc. The innovation capabilities that manufacturing enterprises need to consider in the process of mergers and acquisitions mainly focus on technology research and development and production manufacturing. Non manufacturing enterprises focus more on business model innovation, customer experience, and other aspects. In the process of mergers and acquisitions, non manufacturing enterprises pay more attention to business model innovation and

market expansion capabilities. In terms of market environment and competitive pressure, the manufacturing industry usually faces the pressure of technological updates and fierce market competition, requiring strong innovation capabilities to help enterprises maintain a competitive advantage in market competition and improve merger and acquisition performance. Non manufacturing enterprises may face more challenges from changes in market demand and need to flexibly respond to market changes and provide services that meet customer needs.

Therefore, we will explore the impact of innovation capabilities of manufacturing and non manufacturing enterprises on the performance of corporate mergers and acquisitions separately. The sample of mergers and acquisitions in this study is 2245, involving 449 companies. Among them, the sample of mergers and acquisitions in the manufacturing industry is 1785, involving 357 enterprises; The sample of non manufacturing mergers and acquisitions is 460, involving 92 companies. The specific regression results are shown in Table 7.

Table 7. Regression results between manufacturing and non manufacturing industries

	Model 5	Model 6	Model 7	Model 8
VARIABLES	M-ROA	M-ROA	NM-ROA	NM-ROA
PAT	0.003***	0.003**	0.011***	0.010***
	(2.87)	(2.43)	(3.88)	(2.94)
Scale		0.007***		-0.001
		(4.13)		(-0.21)
Age		-0.001		-0.003**
		(-1.58)		(-2.45)
Ind		0.040		0.121
		(1.02)		(1.19)
MP		-0.009		-0.016
		(-1.36)		(-1.57)
LnGDP		-0.000		-0.000**
		(-1.19)		(-2.17)
UP		-0.003		0.003
		(-0.77)		(0.41)
Constant	0.023***	-0.017	0.012**	0.064
	(10.04)	(-0.55)	(2.12)	(0.87)
Observations	1,785	1,785	460	460
R-squared	0.003	0.018	0.008	0.042
F test	0.00416	6.46e-05	0.000121	0.000502
r2_a	0.00292	0.0138	0.00629	0.0275
F	8.236	4.448	15.04	3.803

*Note: ***, **, and * represent 1%, 5%, and 10% significant level，respectively，and the values in parentheses are t-values*

Table 8. Regression results of major asset restructuring classification

	Model 9	Model 10	Model 11	Model 12
VARIABLES	Involve-ROA	Involve-ROA	Not involve-ROA	Not involve-ROA
PAT	-0.000	0.001	0.004***	0.004***
	(-0.11)	(0.47)	(3.96)	(3.48)
Scale		0.004		0.005***
		(1.27)		(2.95)
Age		-0.000		-0.001***
		(-0.29)		(-2.69)
Ind		0.300**		0.030
		(2.37)		(0.75)
MP		-0.001		-0.005
		(-0.08)		(-0.46)
LnGDP		0.000		-0.000**
		(0.96)		(-1.97)
UP		0.003		0.001
		(0.35)		(0.19)
Constant	0.040***	-0.127*	0.019***	-0.002
	(7.83)	(-1.68)	(8.31)	(-0.06)
Observations	127	127	2,118	2,118
R-squared	0.000	0.092	0.005	0.016
F test	0.914	0.0665	7.59e-05	3.20e-05
r2_a	-0.00792	0.0384	0.00444	0.0127
F	0.0116	1.958	15.72	4.681

*Note: ***, **, and * represent 1%, 5%, and 10% significant level，respectively，and the values in parentheses are t-values*

According to the regression results, the regression coefficient between the innovation achievements of manufacturing enterprises and their M&A performance is 0.003, showing a positive correlation and significant at the 5% level. The regression coefficient between innovation achievements of non manufacturing enterprises and merger and acquisition performance is 0.01, showing a positive correlation and significant at the 1% level. Whether in the manufacturing industry or not, innovation capability is significantly positively correlated with the M&A performance of enterprises. According to market research, non manufacturing enterprises pay more attention to innovation in services, business models, organizational culture, market sensitivity, and brand building. These factors can directly affect customer satisfaction, market share, and overall M&A performance. While manufacturing enterprises are more inclined towards technological innovation to adapt to fierce market competition.

5.2 Analysis of Major Asset Restructuring

Through major asset restructuring, enterprises can optimize resource allocation and achieve synergies. However, major asset restructuring often involves the resources of two or more companies, including talent, technology, patents, and funds. During the integration process, companies need to reconfigure these resources, often accompanied by high levels of uncertainty and risk. Uncertainty may lead companies to adopt a conservative attitude and reduce innovation investment after mergers and acquisitions are completed to cope with potential risks. In addition, major asset restructuring involves the integration of many businesses, assets, and personnel, which will also increase the difficulty of integration after mergers and acquisitions, thereby affecting the performance of mergers and acquisitions.

We divided all samples into two parts: whether they involved major asset restructuring or not. There were 127 events involving major asset restructuring, including 111 companies; There are 2118 events that do not involve significant asset restructuring, including 449 companies. The specific regression results are shown in Table 8.

According to Table 8, the regression coefficient between innovation achievements and M&A performance of enterprises that do not involve major asset restructuring is 0.004, which is significant at the 1% level. The regression coefficient between innovation achievements and M&A performance of sample enterprises that involve major asset restructuring is 0.001, but not significant.

Huang's [37] study found that major restructuring of listed companies does not have a significant impact on the improvement of M&A performance. The regression conclusion shown in Table 8 is consistent with it. Upon investigation, companies that have not undergone significant asset restructuring are typically better able to maintain strategic consistency and long-term development direction, ensuring the sustainability of innovation investment and activities, thereby significantly improving the performance of mergers and acquisitions. However, enterprises involved in major asset restructuring are affected in their investment in innovation due to the reintegration of resources, resulting in insignificant M&A performance.

5.3 Geographic Region Analysis

To further investigate the impact of innovation capabilities of companies in different geographical regions on M&A performance, we classified the sample companies according to their registered locations. The number of sample companies in each geographical region is shown in Table 9.

According to Table 9, the number of companies distributed in East and South China is much larger than that in other regions, accounting for more than half of the total sample companies, totaling 67%. Based on the results divided in Table 9, we continued to use company innovation capability as the explanatory variable and corporate merger and acquisition performance as the dependent variable for regression analysis, and obtained the following results.

Table 9. Number of Companies in Seven Major Geographic Regions

Region	Northeast	North	East	South	Central	Northwest	Southwest	Total
Sample	65	260	1010	505	190	75	140	2245
Proportion	3%	12%	45%	22%	8%	3%	6%	100%

Note：Author's manual organization

Table 10. Regression results of geographical region division

	Model 13	Model 14	Model 15	Model 16
Variables	Northeast	North	East	South
PAT	-0.005	0.003	0.003**	0.003
	(-0.59)	(1.08)	(2.47)	(1.50)
Scale	0.022	0.005	0.002	0.009***
	(1.44)	(1.18)	(0.62)	(2.63)
Age	-0.002	0.000	-0.001**	-0.003***
	(-0.62)	(0.35)	(-1.98)	(-3.44)
Ind	0.007	0.104	0.017	0.046
	(0.03)	(1.31)	(0.36)	(0.49)
MP	-0.112**	-0.025**	0.002	-0.019*
	(-2.12)	(-2.33)	(0.23)	(-1.69)
LnGDP	-0.000	-0.000***	-0.000***	-0.000
	(-1.58)	(-3.26)	(-2.95)	(-1.06)
UP	-0.059	-0.031**	0.005	0.037
	(-1.32)	(-2.49)	(0.74)	(0.60)
Constant	0.437	0.143*	0.038	-0.061
	(1.43)	(1.93)	(0.90)	(-0.33)
Observations	65	260	1,010	505
R-squared	0.214	0.066	0.023	0.048
F test	0.205	0.00561	0.00226	0.00230
r2_a	0.118	0.0396	0.0157	0.0343
F	1.447	2.941	3.212	3.234

Continue

	Model 17	Model 18	Model 19
VARIABLES	Central	East	Southwest
PAT	0.008*	0.021*	0.007**
	(1.76)	(1.96)	(2.30)
Scale	0.013*	-0.026	0.006
	(1.77)	(-1.35)	(1.38)
Age	0.004***	0.012	-0.001
	(2.86)	(1.39)	(-0.91)
Ind	0.177	0.238	0.160*
	(0.97)	(0.74)	(1.83)
MP	-0.028	0.005	-0.005
	(-1.63)	(0.21)	(-0.48)
LnGDP	-0.000**	0.000	0.000
	(-2.60)	(0.22)	(1.22)
UP	-0.043**	0.010	-0.021
	(-2.48)	(0.45)	(-1.58)
Constant	0.073	-0.124	-0.014
	(0.52)	(-0.49)	(-0.18)
Observations	190	75	140
R-squared	0.069	0.102	0.082
F test	0.116	0.565	0.00979
r2_a	0.0336	0.00853	0.0330
F	1.681	0.832	2.787

*Note: ***, **, and * represent 1%, 5%, and 10% significant level，respectively，and the values in parentheses are t-values*

According to Table 10, the regression coefficients between enterprise innovation output and M&A performance in East China and Southwest China are 0.003 and 0.007, respectively, and both are at a significance level of 5%. The regression coefficients of innovation output and merger and

acquisition performance of enterprises in Central China and Northwest China are 0.008 and 0.021, respectively, and are significantly positively correlated at the 10% level. The innovation output of enterprises in North and South China is positively correlated with their merger and acquisition performance, but the correlation is not significant. The regression coefficient between enterprise innovation output and merger and acquisition performance in the Northeast region is -0.005, which is the only region among these seven geographical regions that shows a negative correlation, but not significant.

The East China region is in a leading position in China's economic development, with complete infrastructure, sufficient human resources, and a strong urban agglomeration, which provides a favorable ecological environment for enterprise innovation. The industrial structure in East China is also more diversified, covering many high-tech industries and service industries, which provides enterprises with broader innovation space and market opportunities. The southwestern region has abundant natural resources, including water resources, mineral resources, etc. The abundance of these resources may encourage enterprises to exert greater creativity in resource development and utilization. Central China is an important industrial base and transportation hub in China, with abundant resources and demographic dividends. The northwest region has abundant mineral and agricultural resources, and both regions have invested heavily in scientific and technological innovation, building a number of high-level research institutions and universities, such as Huazhong University of Science and Technology and Zhengzhou University. A large number of high-quality talents provide innovation support for enterprises and help them improve merger and acquisition performance, thereby achieving synergies.

Enterprises in North China are more concentrated in government led and traditional industries, and pay more attention to the maintenance and stable operation of traditional industries, which may not be a significant reason. The South China region is at the forefront of China's reform and opening up, with relatively early economic development and a mature industrial chain that is difficult to be influenced by other factors, so it is not significant. The non significant negative correlation in the Northeast region may be caused by the small sample size and low fitting degree of the regression model.

6. CONCLUSION AND IMPLICATION

6.1 Conclusion

Firstly, through the regression analysis mentioned earlier, it is concluded that a company's innovation capability has a positive promoting effect on its M&A performance. The innovative achievements possessed by the main acquirer can establish an excellent brand image, enhance its position and recognition in the market, help the main acquirer consolidate its leading position in the industry, and attract more customers and partners. In addition, companies with strong innovation capabilities are often able to better integrate various resources after mergers and acquisitions, achieving complementary advantages for both parties. Furthermore, companies with high innovation capabilities also demonstrate better information disclosure and transparency, providing accurate financial information and reducing the occurrence of agency problems. Decision makers in corporate mergers and acquisitions can make optimal decisions based on this, reduce merger and acquisition risks, and thus improve the performance of corporate mergers and acquisitions.

Secondly, through further research, we also found that innovation capability is significantly positively correlated with the M&A performance of enterprises, regardless of whether they are in the manufacturing industry or not, mainly due to the different innovative directions of the two. Non manufacturing enterprises pay more attention to innovation in services and business models, while manufacturing industries are more concerned with technological innovation. In addition, we also divided the sample into whether it involves significant asset restructuring and analyzed each sub sample separately. The empirical results show that the innovation achievements of sample companies that do not involve major asset restructuring are significantly positively correlated with their M&A performance at the 1% level, while the innovation achievements of sample companies that involve major asset restructuring are not significantly correlated with their M&A performance. This may be because major asset restructuring events can occupy important resources of the enterprise and reduce investment in innovation. Enterprises that have not been involved in major asset restructuring, due to their consistent personnel structure and relatively concentrated resources, are able to respond more quickly to market

changes, thereby better achieving sustainable innovative development and improving merger and acquisition performance. Finally, we also divided the sample into different geographical regions, and the empirical results showed that the innovation output of enterprises in East China, Central China, Northwest China, and Southwest China was significantly positively correlated with their merger and acquisition performance; However, it is not significant in North China, South China, and Northeast China. The reason for this is that the industrial structure in East China is rich and complete, which can provide enterprises with broader innovation space and market opportunities. The abundant natural resources in the southwest region can encourage enterprises to unleash tremendous creativity in resource development, utilization, and innovation. The Central and Northwest regions have abundant resources and talent advantages, providing sustainable innovation support for enterprises. In contrast, enterprises in North China place greater emphasis on the maintenance and operation of traditional industries. The economic development in southern China is relatively early, and a mature industrial chain has been formed, placing more emphasis on stability rather than innovation. The reason for the non significant negative correlation in the Northeast region may be due to the small sample size and low fitting degree of the regression model.

6.2 Implication

Firstly, attach importance to the research and innovation of technology. It is recommended that companies increase their investment in technology research and innovation, including establishing dedicated R&D departments, recruiting high-quality R&D teams, and establishing laboratories and technology centers. At the same time, adopting an open innovation strategy, actively absorbing external innovation resources, such as introducing foreign innovative technologies, acquiring innovative enterprises, etc., to broaden the sources and channels of innovation and accelerate the development of one's own innovation capabilities.

Secondly, companies should evaluate the innovation capability of the target company before mergers and acquisitions to ensure that the merger can bring more strategic advantages and performance to the company. In addition, companies should not blindly engage in merger and acquisition activities. Before making merger and acquisition decisions, it is necessary to fully evaluate the strategic activities that have been carried out, such as major asset restructuring events, to avoid unnecessary merger and acquisition risks.

Thirdly, pay attention to the market opportunities in the East and Southwest regions. Enterprises in the East and Southwest regions should make good use of local resources, formulate clear innovative development strategies, create a favorable business environment, and thus achieve synergies in mergers and acquisitions.

6.3 Limitations and prospects of research

The sample of this study mainly selected merger and acquisition data of Chinese listed companies, and did not cover data of non listed companies or other types of enterprises. Therefore, the research conclusions for non listed companies and other groups may not be generalizable. In future research, we will cover more sample data and longer study periods to improve the applicability of research conclusions. In addition, we will consider introducing more variables that may affect the relationship between corporate innovation capability and merger and acquisition performance through literature review, providing more specific and actionable suggestions for corporate management. Finally, in future research, interdisciplinary collaboration will be strengthened, combining theories and methods from multiple disciplines such as management, economics, sociology, etc., to explore in depth the relationship between corporate innovation and M&A performance, providing more comprehensive and in-depth theoretical support for practice and policy.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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