RESEARCH ON THE IMPACT OF MERGERS AND ACQUISITIONS TRANSACTION SIZE AND INNOVATION PERFORMANCE OFPHARMACEUTICALS INDUSTRY

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ABSTRACT

With the gradual expansion of China's economy, the demand for innovation and growth of China’s companies is increasing. Traditional internal research and development (R&D) and iterative product and service development are no longer sufficient to meet the fierce market competition. More and more companies are seeking breakthrough growth of overall technology, brand, and service. Therefore, mergers & acquisitions (M&A) have become a common business activity for China’s companies. The motivation of company’s M&A is complex, and as M&A laws in China and worldwide become more complicated, how to make rational and rapid M&A that can achieve strategic upgrading of enterprises has become a research issue of concern for Chinese economic, financial, accounting, and legal disciplines, etc. As a basic industry, Chinese pharmaceutical industry has not yet taken a dominant position in the world. Due to the intertwining of multiple disciplines and complex background information, the impact of M&A transaction size on the innovation performance of pharmaceutical companies has yet to be studied.

Focusing on the two hot spots: M&A and innovation, in the context of China's economic transformation and upgrading, this dissertation explores the impact of M&A on innovation based on the current situation analysis and theoretical analysis, and deeply studies and reveals the mechanism and effect of M&A transaction size on company innovation. 281 M&A data of 58 listed companies in China's healthcare industry from 2008 to 2017 was collected and regression analysis was performed to examine the impact of M&A transaction size on the innovation level of companies in terms of two aspects: the number of patent applications and the number of patents granted, and on three levels: invention patents, utility model patents and design patents. The results of the research

show that: M&A transaction size promotes the growth of the number of patent applications and patents granted and has a significant positive effect on enterprise innovation; and M&A transaction size has contributed to the increase of the number of utility model patent applications and patents granted. In general, the innovation performance of M&A transaction size in utility model patents is better than that in invention patents with higher technological elements. Further mechanism examination results show that the innovation performance of a company after a bigger M&A transaction is influenced by its absorptive capacity: the stronger its absorptive capacity, the more opportunities it has to absorb and transform the technologies and knowledge of an acquired enterprise into its own. Through learning and imitation, it realizes the transformation and innovation of the technologies obtained through M&A, ultimately enhancing its innovation capability.

Keywords: M&A transaction size; corporate innovation; absorptive capacity; pharmaceutical companies

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I am a big fan of challenges such as mountain climbing. One can see farther if they stand higher. Just as the famous Chinese saying goes - Climb to a greater height and you can enjoy a grander sight.

On the journey towards "investment M&A", I have gone through dozens of hardships and setbacks. Since joining Pfizer, the largest pharmaceutical company in the world, in 2006, I have been inseparably tied up with investment M&A, witnessing a series of major M&A cases in the company's history while encountering failures. With both rich experience and confusion, I was finding myself back in college pursuing a doctoral degree in Finance.

During the four years in college, I have had a part in hundreds of investment and M&A projects in the hope that theory can be combined with practice. As a matter of fact, I have improved myself considerably on the long journey where I have feasted my eyes on “beautiful scenery”.

I sincerely thank the teachers of Temple University and PBC School of Finance, Tsinghua University for helping me to build a complete financial knowledge system, as well as my classmates for enabling to go farther on my journey. In particular, I would like to thank my thesis instructor Professor Xiaohui Gao Bakshi, and three professors of the thesis defense committee Gurdip Bakshi, Pallavi Chitturi, Sudipta Basu for their guidance.

I would also like to thank my parents, wife and two daughters for their strong support. During the four years I spent little time with my family about which I feel guilty.

When asked why he wanted to climb Mount Everest, George Mallory, a famous British mountaineer, said: Because it's there. On my journey towards "investment and M&A", I will set my mind on my destination and keep going - Because it's there.

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CHAPTER I

INTRODUCTION

Research Background

M&A is an acronym for mergers and acquisitions, and is a term used in strategic management, corporate finance and management, referring to the purchase, sale, spin-off, and merger of different companies or similar entities without using the creation of subsidiaries or joint ventures to help companies grow rapidly in their field, industry, or location. Accounting standard IFRIC 3 - Business Combinations defines M&A as a transaction or other event in which the acquirer obtains control of one or more enterprises. In China, the distinction between a "merger" and an "acquisition" is narrow as discussed in detail in Chapter 2.1.1. With their own strength, Chinese companies are expanding their business through M&A.

According to PwC's *Review of China's M&A Market in 2020 and Prospects for 2021* report, the deal value of M&A activity in China grew by 30% to RMB 733.8 billion in 2020, the highest level since 2016, mainly due to strong investment support from State-owned Enterprises (SOEs) and government funding. The number of M&A deals increased by 11% over the previous year, with a decrease in cross-border deals and a significant increase in private equity fund activity. China accounts for approximately 15% of the global M&A market in terms of deal volume and value and plays an increasingly important role in the global market. The Chinese government's policies and strategies such as further globalization, "industrial upgrading", "dual circulation economy" and regional economic integration are affecting the Chinese M&A market. At the same time, the RCEP (Regional Comprehensive Economic Partnership Agreement) brings

opportunities for China and East Asia to significantly enhance the global competitiveness of outstanding Chinese companies, and to promote their upgrading and M&A.

In 2020, Chinese pharmaceutical and life sciences industries disclosed 928 deals with a total value of RMB 43 billion, an increase of approximately 73% over the previous year, with the number and value of deals in both the pharmaceutical and device segments reaching a record high in the past five years. According to *China M&A 2020 review & 2021 outlook: Pharmaceutical and Life Science Sectors* released by PricewaterhouseCoopers, boosted by a series of favorable policies such as the fourth round of volume-based procurement, the deepened medical insurance reform, the innovation incentives, and the loosened new regulations on listing and refinancing in the capital market, a blowout was seen in the investment in the pharmaceutical sector in 2020. With 635 deals reached and an increase of about 45%, the total deal size reached USD 35.1 billion. Excluding the impact of BeiGene's mega-deal, the deal size increased by 70% from USD 19.4 billion in 2019.

The demand for consolidation of scarce assets (in vitro diagnostics, medical consumables) by domestic strategic investors under the impact of the COVID-19 and the quick exit mechanism provided to financial investors have enabled the medical device industry to stop the decline in 2019. The number of deals reached 293 in 2020, an increase of approximately 94%, and the value of deals reached RMB 8 billion, a strong increase of 196% over 2019 (RMB 2.7 billion). A total of 22 deals with each valued over RMB 100 million accounted for 64% of the total value of deals for the year (only 9 deals with each valued over RMB 100 million accounted for 56% of the total value of deals in 2019).

Among these deals, the number of overseas M&A declined significantly, but biology and biotechnology industries maintained active trading, mainly influenced by the COVID-19 and China's national policy guidance to encourage scientific and technological innovation in developing new drugs and vaccines, as well as the capital market's overall bullishness on biotechnology. The number of M&As in this field surpassed that of the traditional pharmaceuticals industry in 2020. It can be seen that Chinese pharmaceutical companies tend to enhance their innovation strength by M&A. Currently, the listed companies in China's pharmaceutical industry are facing uncertainties such as health care system reform, and the companies with core resources are more likely to gain competitive advantage, so many companies are trying to integrate resources to strengthen themselves through M&A. Its motivation and mechanism of action deserve to be explored by researchers.

Purpose and Significance

The global economy has entered a new stage of development. With sluggish growth in demand and rising protectionism in global trade, a downward pressure is increasing on China's economy, posing challenges to its economic transformation. In the government’s work report, Premier Li Keqiang pointed out that “innovation should lead the transformation and upgrading of the real economy”, and “we must deepen the innovation-driven development strategy, promote the optimization of the structure of the real economy, and continuously improve its quality, efficiency and competitiveness.” In an increasingly volatile and complex technological and market environment, companies are eager to improve their innovation capabilities.

Meanwhile, as Chinese companies are playing an increasingly important role in the M&A market, scholars are paying more attention to M&A in China. As an effective way to enhance a company's innovation capabilities, M&A can be a relatively quick way for the company to acquire the knowledge and technologies possessed by the target company and combine them to complement its own resources. The relationship between M&A and a company's performance has been studied in depth by domestic and international scholars, but most of the literature focused on the relationship between M&A and financial performance, such as the impact of M&A on a company's profitability, operations, and growth. Few of these studies involve innovation, and the existing studies related to innovation performance tend to have a limited number of observations and lack generality analysis and demonstration of micro-level data.

In this dissertation, the domestic M&A deals of Chinese listed companies are analyzed. Surrounding the two hot spots, i.e., M&A and corporate innovation, a large number of M&A events are selected to study whether M&A transaction size can promote companies' innovation performance, and further analyze the impact of M&A transaction size on a company's innovation level.

Specifically, the significance of this research is as follows:

(1) Based on existing domestic and international research results, as well as Chinese national conditions and the status quo of M&A, establishing an analytical framework to deeply explore the M&A in the domestic healthcare industry will further contribute to theoretical research in the field of M&A;

(2) Based on the resource-based theory, corporate innovation theory and other related theories and research methods, theoretical analysis and empirical analysis are

flexibly conducted to explore the mechanism of the role of M&A transaction size on corporate innovation;

(3) Based on empirical research, this dissertation analyzes the impact of enterprises' absorption and transformation capability on enterprises' innovation capability;

(4) On the basis of empirical research, the research results can provide a basis for the decision-making of relevant companies and government departments, who can then make corresponding conclusions and put forward suggestions.

Framework, Content, Methods and Innovations of the Research

Framework. The framework of the research is as follows:

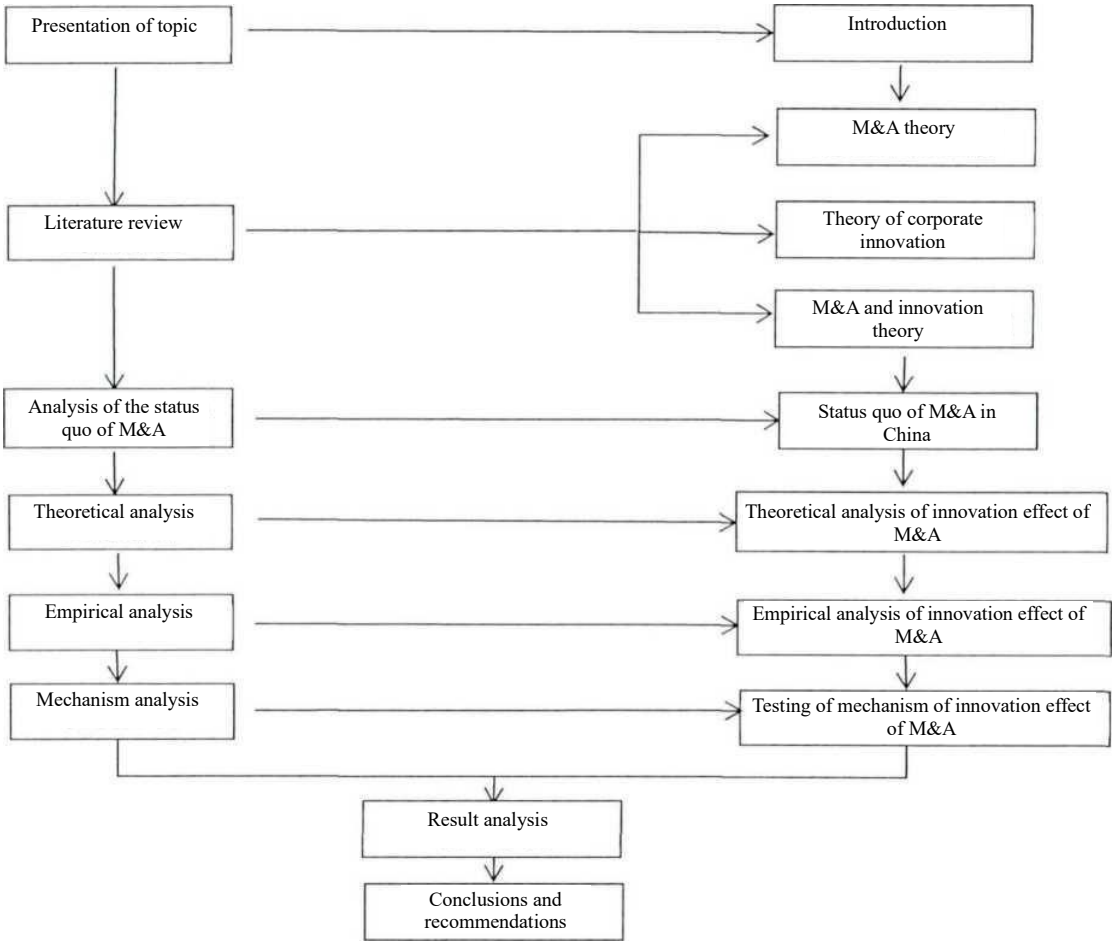

Figure 1-1 Framework of the Research

Methods. (1) Literature study

Chinese and foreign academic literature on efficiency theory, agency theory, corporate innovation theory, M&A of Chinese companies, the relationship between M&A and corporate innovation, and the status quo of Chinese patent development was extensively reviewed. The knowledge background of the research was summarized through reading by category. The industry development reports and related statistics

released by the industry for several years were also summarized, laying the foundation for the entire research.

(2) Descriptive statistics

The characteristics of China's M&A market from 2008 to 2017 were collated and analyzed. On this basis, the M&A of listed companies in China's healthcare sector is selected as a sample to analyze the domestic M&A of companies during the research process, focusing on the impact of domestic M&A on corporate innovation.

(3) Theoretical model analysis

In this research, the research models of domestic and foreign scholars were used for reference, combined with the research object of this dissertation, to build a theoretical model to analyze the relationship among corporate innovation, M&A and corporate absorptive capacity and the mechanism, and relevant hypotheses were proposed.

(4) Empirical research

Using the panel data of listed companies from 2008 to 2017 for fixed-effects regression, regression analysis and other methods, the impact of domestic M&A on the level of corporate innovation was studied, focusing on exploring whether M&A transaction size can promote corporate innovation and testing its impact mechanism.

Innovations. Unlike the existing M&A-related literature, the possible innovations of this research are reflected in the following three aspects: 1. perspective innovation. Based on the status quo of patent applications and patents granted of companies, the impact of M&A transaction size on corporate innovation was analyzed in terms of both the speed and quality of M&A on the improvement of their innovation capabilities; 2. theoretical analysis. Based on the differences and similarities in the motives and

capabilities of companies choosing M&A, an in-depth analysis of the mechanism of the impact of M&A transaction size on corporate innovation was conducted; and 3. empirical analysis. Based on a large sample of listed companies, regression analysis and other empirical methods were used to analyze the innovation effect of M&A transaction size in the domestic healthcare industry on the companies. The M&A market in China, the largest developing country in the world, is special. Based on the actual national conditions, this dissertation further explores whether M&A transaction size will promote corporate innovation, and explains the innovation effect of M&A transaction size and its impact mechanism through empirical analysis. In addition, China, as a transition country, is in a critical stage of economic transformation and upgrading, while there is limited research on M&A in transition countries. Thus, this dissertation is also of reference value in studying the M&A in China.

CHAPTER II

LITERATURE REVIEW

The wave of M&A in the world started from the western countries and swept the globe all the way to China at the end of the 20th century, and M&A has gradually become the only way for Chinese companies to grow bigger and stronger. Can innovation, a pressing need for the development of the country and companies in the current economic context, be achieved through M&A? The theories related to M&A and innovation are reviewed and summarized in this chapter.

Overview of Research on M&A

Concept and Classification of M&A. Wang (2003) compared the concept of M&A in the west and in China. In western countries, mergers and acquisitions (M&A) refers to refers to M&A of companies. There are connections and differences between the two activities. The New Encyclopedia Britannica explains a merger as a merger of two or more independent enterprises or companies to form a single business, usually by the absorption of one or more companies by a dominant one. The act of merger can be accomplished: 1) by purchasing the assets of the target company with cash or securities, or 2) by purchasing shares or stocks of the target company, or 3) by issuing new shares to the shareholders of the target company in exchange for the equity they held, to acquire the assets and liabilities of the target company. Acquisition, on the other hand, refers to the purchase of shares and assets of the target company by one or more companies in the securities market with cash, bonds or shares to gain control of that company, whose legal personality stays. Wang pointed out that in China, M&A are generally referred to as enterprise mergers, which usually refers to the economic act of one company buying the property rights of other companies with cash or securities or in other ways (such as

assuming debts, repaying profits, etc.) to make the companies lose their legal personality or change their legal entity and gain the decision-making rights and control over these companies. In this sense, M&A is equivalent to the merger by absorption stipulated in the Company Law of China.

During the M&A process, the dominant company maintains its name and independence and acquires the property, responsibilities, privileges, and other rights of the absorbed company, which then ceases to be an independent trading group. This process can be expressed by the formula "A+B=A". (Fan, 2004)

Liu & Han (2003) conducted a further study of M&A models, as shown in Table 2-1.

Table 2-1 Classification of M&A Models

	Horizontal M&A	Vertical M&A	Conglomerate M&A
Definition	Horizontal M&A deals occur between companies that produce products of similar categories or similar products, or use similar production technologies.	Vertical M&A deals occur between companies that have a sequential connection in production process or distribution and are vertically integrated.	Conglomerate M&A deals occur between companies, which are neither in a competition nor in an input-output relationship, in different sectors.
Purpose	To expand the market share of the company and gain an edge in competition	To strengthen the coordination of the production process and various links to achieve strategic synergy	To implement diversification strategy and reduce corporate risks

Table 2-1 Classification of M&A Models (Continue)

	Horizontal M&A	Vertical M&A	Conglomerate M&A
Positive effects	Economies of scale: -Reduced fixed cost per unit -Professional effect -Learning effect -Reduced purchasing cost -Synergistic effect	Reduced transaction costs: -Reduced cost of search process -Reduced bargaining cost -Reduced cost of performance -Can effectively reduce moral hazard	Achieved economies of scope: -Effective combination in production -Effective combination in raw material application -Market portfolio effect -R&D portfolio effect -Intangible assets portfolio effect
Negative effects	Diseconomies of scale: -Management complexity -Weakness of incentives -Management system inefficiency -Reduced drive to innovate -Increased corporate risk -Limitations of technology	Rising administrative costs: -Rising costs of internal incentives and constraints -Increased information cost	Risk of strategic choices: -Unfamiliar with new fields and subject to uncertainties in technology, business, management, market, etc. -Excessive investment of resources in non-related businesses, weakening the development of the company's main business -Possible debt ratio rise, deteriorating financial situation

Analysis of Motivation of M&A. M&A is motivated by a series of complex factors. Chinese and foreign scholars have conducted extensive and in-depth research on the motivations for M&A and put forward typical theories.

1. Efficiency theory

Liu (2004) made a detailed exposition of the efficiency theory. The efficiency theory argues that M&A activities can improve companies' business performance and increase social welfare at the same time. Specifically, the efficiency theory can be divided into economies of scale theory, management synergy theory, operational synergy theory, and financial synergy theory.

(1) Economies of scale theory

The modern industrial organization theory studies the relationship between economies of scale and economic efficiency of companies, and the results show that there is a positive correlation between a company's size and its profit rate. As the size of a company increases, more effective division of labor and collaboration can improve production efficiency and reduce the unit cost of products. In addition, economies of scope can also produce significant cost reduction effects. Companies carrying out co-production can share research, management, and marketing expenses on a larger scale, thereby reducing the unit cost of products. According to the theory of economies of scale, companies that did not operate at the level of economies of scale before M&A can achieve economies of scale and expand their benefits through M&A.

Specifically, M&A can bring the benefits of economies of scale to companies both internally and externally. (1) Internal economies of scale: Through M&A, companies can supplement and adjust their assets. Through horizontal M&A, companies can realize unified and standardized production and reduce fixed costs of products brought by multiple operations, while through vertical M&A, various production processes can be integrated into one company, thus saving transaction costs. (2) External economies of scale: M&A can enhance the overall strength of companies, increase their market share, and enable them to provide more comprehensive and professional production service, thus better satisfying the needs of different markets.

(2) Management synergy theory

The management synergy theory, also known as differential efficiency theory, mainly involves the changes in efficiency brought by M&A to the management activities

of companies and the benefits generated by the improvement of efficiency. If the management efficiency of two companies is different, after the company with high management efficiency merges with another company, it can help the inefficient company to improve its management efficiency and release its excess management capacity, thereby improving overall efficiency. This effect is referred to as management synergy. Management synergy stems from the inseparability of industry and company-specific management resources, but it generally occurs in specific industries only. Relatively, this theory is more explanatory for horizontal M&A.

(3) Operational synergy theory

The operational synergy theory mainly involves the changes in efficiency brought by M&A to the production and operation activities of companies and the benefits generated by the improvement of efficiency. According to this theory, when two or more companies with complementary production and operation merge into one company, they can take advantage of each other's strengths and produce extra benefits. If one company is strong in R&D but weak in management and marketing, and the other is in the opposite case, the merger of the two can help them overcome their respective shortcomings, achieve mutual complementarity, improve the overall efficiency, and bring additional value.

(4) Financial synergy theory

The financial synergy is mainly reflected in two aspects. Firstly, by investing the acquiring company's internal funds with low capital cost in the high-efficiency projects of the acquired company, the capital utilization efficiency of the company after merger can be improved. Those companies that have entered a mature stage after a long time of

development often have abundant internal cash but lack suitable investment opportunities. Their merger with companies that have good investment opportunities but lack funds can enable them to use funds more rationally and scientifically. Secondly, the debt-raising capacity of the company after the merger is greater than the sum of their respective capacity before the merger, and it can also save the investment income tax.

2. Agency theory

According to the agency theory, M&A can pose an effective threat to existing management and is an important way to solve the problem of agency. In their paper, Jensen and Meckling (1976) elaborated on the meaning of the problem of agency. The problem of agency arises when the manager holds only a small fraction of a company's ownership, in which case the manager may use his/her managerial prerogatives to pursue private interests. Fama (1980) and Fama and Jensen (1983) argued that the problem of agency can be mitigated through compensation arrangements, manager markets, efficient stock markets, and mechanisms that separate ownership from control of the company. When none of these mechanisms are sufficient to control the agency problem, takeover will likely be the last external control mechanism (Manne, 1965). A takeover resulting from a public takeover or proxy contest will result in the removal of current managers and board members and their replacement by other potential managers and directors. Manne also highlighted that the M&A mechanism will lead to the long presence of the threat of takeover if the company is underperforming due to inefficiency or the agency problem.

3. Undervaluation theory

The undervaluation theory says that when the market value of the target company fails to reflect its real or potential value for some reason, other companies may acquire it. Zhang (2009) pointed out that the undervaluation theory can be divided into short-sighted theory, Tobin's Q theory and information asymmetry theory depending on the reasons why the target company is undervalued:

According to the short-sighted theory, the main reason for the undervaluation of companies lies in market participants, especially institutional investors. They put too much emphasis on the short-term business results, performance, and profits of companies, and ignore the long-term interests and goals, thus leading to the underestimation of companies with long-term investment plans, which are regarded as ideal M&A targets by many companies or individual investors with discretionary funds and resources.

Tobin's Q theory was proposed by economist Tobin in 1969, who used the Tobin's Q ratio to indicate the ratio of the market value of a company's stock to the replacement cost of the assets represented by the stock, and argued that when a target company's stock price is lower than the replacement cost of its assets, it is cheaper to acquire the assets needed for expansion by purchasing the company's stock than to purchase the assets in question. Tobin used the Q value to reflect the likelihood of M&A. If Q is less than 1, the smaller the value is, the more likely the company is to be acquired. This theory provides a criterion for selecting M&A targets, and the key to its application is how to correctly value target companies. However, it has some limitations: in practice, M&A targets are not only undervalued companies.

The information asymmetry theory points out that even in developed capital markets such as European and American countries, the stock market price can only reflect all public information, excluding undisclosed "insider information". Some powerful institutions or large companies usually have considerable advantages in information, as they are more likely to access "insider information" about a company's competitive position or future development prospects compared with average investors, while the market as a whole has no access to it. An informed person who discovers that the market price of the company's stock is lower than its true value may take advantage of the opportunity to acquire its stock. Another hypothesis, which is similar to the above theory, assumes that the management of certain companies has superior analytical skills and is very sensitive in discovering new information or opportunities, and that they can continuously track and investigate a large number of potential M&A targets and quickly identify companies that have abundant resources or great growth potential but are unfortunately undervalued by the capital market.

4. Transaction cost theory

Wei (2005) conducted a systematic study on the development of transaction cost theory, which will be used as the basis for a brief review of the theory.

The transaction cost theory was first proposed by Coase (1937). He explained the motivation of M&A from the perspective of the nature of companies, arguing that companies are a substitute for the market mechanism, and that the market and companies represent two ways of resource allocation and can replace each other under certain conditions. The expansion and contraction of a company, that is, the boundary between a company and the market, depends on the comparison of the company's internal

organizational costs and market transaction costs. Vertical M&A is economically feasible if the market transaction costs reduced by the company through the M&A exceed the increased internal management costs.

Williamsion (1975) systematically refined Coase's theory by pointing out that the boundary condition for a vertical M&A is that the company's marginal transaction cost savings equal the marginal organizational cost increase, and that achieving this equilibrium in a vertical M&A can lead to an efficient organization of production and distribution and an efficient allocation of resources.

Grossman and Hart (1986) pointed out that it is contractual incompleteness that determines transaction costs, and that the more complete the contract is, the more likely the opportunistic behavior can be eliminated. However, the real economy is full of uncertainty, and there are no complete contracts. The motivation of vertical M&A is that M&A can eliminate the opportunistic behavior by transferring the transaction within the company where it is not possible to enter into a complete contract to limit the opportunistic behavior caused by asset specificity.

Based on the transaction cost theory, Chinese scholar Zhang Wuchang gave a new boundary condition for M&A, in which companies are not created to replace markets, but merely to replace product markets with factor markets, or to replace one type of contract with another.

5. Market power theory

Market power enables companies to gain monopoly profits and increase their ability to make profits in the long run. Meeks (1977) argued that M&A can reduce the number of competitors and expand a company's market share, thereby enhancing its control of the market.

The core idea of this theory is that expanding the size of a company will increase its power. Regarding this issue, people often assume that an important motivation of M&A is to expand the company's market share, but they are not clear how increasing market share leads to synergy. If increasing market share simply means making the company bigger, then it is still economies of scale that are at play. In fact, increasing market share means increasing monopoly power, i.e., increasing the size of a company relative to other companies in the same sector. There are two opposing views on market power in academia. One is that increasing a company's market share will lead to collusion and monopoly, thus resulting in the benefits of M&A. Therefore, in many developed market economies, governments restrict monopoly and encourage competition by establishing appropriate laws and regulations. The other argues that the increase in industry concentration is the result of fierce market competition. They further explained that competition has become increasingly intense among large companies in highly concentrated industries. Simple collusion is impossible as decisions on price, output, product type, product quality and service involve numerous dimensions at complex levels (Huang, 2007).

The two contrasting views show that there are still many disagreements and unanswered questions regarding the market power theory.

Analysis of Effects of M&A. The analysis of the effects of M&A involves the change of the company's profitability and the change of social welfare after the M&A.

Fan et al. (2002) believed that the nature (growth, maturity, and decline) of the industry in which a company is engaged in largely influences the effects of different types of M&A. They conducted an empirical analysis using 336 M&A of listed companies in China from 1995 to 1999. The results showed that companies in growing industries had the best relative performance in horizontal M&A; companies in mature industries received the most gains in vertical M&A; and companies in declining industries presented the poorest performance in horizontal M&A.

Malmendier and Tate (2008) found that CEOs often overestimate their ability to generate revenue and are therefore prone to implement M&A that may undermine the value of their companies.

Chen (2006) used the standard event study method and the accounting study method to calculate the performance measures of companies - cumulative adjusted return (CAR), average earnings per share, and average return on equity, and analyzed the performance of Chinese target companies in the short and long term, respectively. The main conclusion drawn from the empirical study is that foreign M&A transactions had no significant impact on the performance of Chinese target companies during the event period. Yu (2011) examined the relationship among M&A, executive characteristics and performance of companies using a panel data model with Chinese A-share listed companies from 2007 to 2010 as the sample. The empirical study results show that: (1) M&A events have a significant negative impact on the performance of a company; (2) If the executives hold the shares of a company, it can partially improve the degree of M&A

events' negative impact on the company's performance although a directional change is not likely; and (3) The strong control of executives over the company cannot mitigate, but will amplify, the significant negative impact of M&A on the company's performance.

In general, most of the current academic research concludes that M&A activities will brings negative returns to the merging company. As for the effects of M&A on social welfare, there is no consistent view among domestic and foreign scholars.

Steward and Kim (1993) conducted an empirical analysis of M&A activities in one of the manufacturing industries in the United States from 1985 to 1986 and found that companies had different motivations to carry out M&A, including economic purposes such as gaining market power, saving economic costs, and pursuing private profit increases, as well as non-economic purposes such as satisfying individual vanity. After analyzing the welfare effects of all the above M&A behaviors, they concluded that the benefits gained by the M&A companies and other companies in the industry were not enough to make up for the losses of consumers, resulting in negative total social welfare impact.

Guo and Qu (2004) conducted a partial equilibrium analysis of several possible scenarios in which M&As can occur based on a comprehensive consideration of the potential monopoly that can be created by M&A and the efficiency advantages they generate, in order to elucidate the impact of M&A on social welfare. They concluded that for cases in which product prices increase due to increased market monopoly power after M&A, if the efficiency advantage reaches a certain level, it can still improve social welfare; for case in which prices decrease after M&A, the M&A unconditionally increases social welfare. This conclusion provides useful insights for China to reform the

company property rights system, improve the capital market, and promote the market-oriented, socialized and standardized development of M&A.

Post-M&A Integration. Haspeslagh and Jemison (1991) pointed out that post-M&A integration is the source of value creation and an important guarantee for the success of M&A.

Li and Gao (2001) generalized the definition of post-M&A integration as a systematic arrangement of corporate elements such as assets and personnel after one party acquires the asset ownership, equity or operational control of the other party, so that the post-M&A company organizes its operations according to certain M&A objectives, guidelines and strategies.

Zhao (2000) believed that there are operational, management, financial and information risks before and after M&A, and the ultimate purpose of M&A must be achieved through the integration of all resources after M&A. Specifically, post-M&A integration is necessary for three reasons: (1) Before the M&A, the acquirer and the acquiree are two independent companies. They may produce the same type of products, or their products and technologies may be completely unrelated. They may have independent production and operation systems, business objectives and operation methods. After the M&A, the priority is to find out how to make the original two independent systems operate more effectively; (2) M&A is the result of market competition where the fittest survives. In China, the acquired companies are often inferior with problems such as poor management, financial difficulties, and investment mistakes. After the M&A, it is necessary to transform and reorganize their personnel and assets, to avoid being dragged down and assimilated by the inferior companies; (3) From a macro

perspective, M&A can change the structure of the existing asset stock and improve the efficiency of the assets, but this can be truly achieved through post-M&A integration and transformation.

Xu (2000) pointed out that the post-M&A integration can be carried out in organization, finance, and culture, and summarized the post-M&A integration models into four types according to the differences in the system, organization, mechanism and culture between the two sides: (1) Assimilation. It is adopted when the acquirer is superior to the acquiree in terms of system, organization, mechanism and culture, and the acquiree's position is obviously weaker. In this model, the conflicts of companies are not intense, the integration cost is low, the time spent is limited, and the excellent culture of the acquirer is diffused; (2) Forced entry. It is adopted when the acquirer is obviously superior to the acquiree in terms of system, organization, mechanism and culture, and both parties refuse to integrate. In this model, there are intense conflicts between the two sides, high integration risks exist and high costs are required. Entrepreneurs are the initiators and promoters of such integration, and the excellent culture of the acquirer is diffused; (3) Separation. It is adopted when the two parties have their own characteristics and advantages in terms of system, organization, mechanism and culture. In this model, the integration process is smooth. The parties are not subject to significant fluctuation of production and operation of both sides, and preserve their independence while achieving mutual complementarity; (4) New establishment. It is adopted when the acquirer has certain defects in terms of system, organization, mechanism and culture. In this model, there is little conflict between the two sides, but the integration is more costly and risky. The effects after integration are obvious.

Guan and Zhuang (2005) put forward a post-M&A integration model based on core competencies, as well as five integration selection modes according to the three states of core competence: basic, sub-mature and mature. Based on the integration models proposed by Xu (2000), absorption was added. In this model, the integration process is smoother, with little conflict between the two companies. The core competence of the acquiree is transplanted to the acquirer, strengthening that of the latter.

Corporate Innovation

The Concept of Corporate Innovation. The etymology of innovation comes from the Latin verbs "innovare" and "innovus," meaning to renew, innovate, make new thing, to make something different from the old thing. The "innovation" and innovative activities involved in this article are based on the economic innovation concept that from the book by Schumpeter (1912) at Harvard University Theory of Economic Development, which proposed a new Innovation Theory of "new combinations of production factors" and "economic growth." The purpose of innovation is to obtain potential profits. This "new combination" is often "discontinuous." The existing organization may produce innovation, however, most of the innovation occurs outside the existing organization.

Starting from the 1960s, as industrialization progressed, the use of new technologies in traditional industries led scholars to expand the scope of "innovation" to technology and organizations. Enos (1962) put forward the definition of technological innovation from the perspective of organizational behavior in Invention and Innovation in the Petroleum Refining Industry: "Technological innovation is the result of a combination of several behaviors, including the choice of invention, the assurance of capital investment, the establishment of organizations, the development of plans, the recruitment

of workers and the opening of markets." Drucker (1966) proposed that innovation is a basic function of organizations and an important responsibility of the management. Prior to this, "management" was generally considered as organizing existing businesses in an orderly manner, improving quality, processes, reducing costs, increasing efficiency, and so on. Drucker, however, introduced innovation into management and made it clear that it is the daily work and basic responsibility of every manager and knowledgeable worker. Mills & Marguis (1969, 1976) defined innovation as a collection of technological revolutions. They believe that technological innovation is a complex process of activities, starting with new ideas and concepts, and through continuous problem solving, eventually making a new project of economic and social value to be applied successfully in practice. Imitation and improvements that do not require the introduction of new technological knowledge are included in the definition of technological innovation as two types of innovation at the final level.

Innovation includes the following 5 aspects:

1. Introduction of a new product or give a new feature to a product;

2. Introduction of new production methods, mainly in the form of new processes or new ways of organizing the production process;

3. Opening up a new market;

4. Access to a new source of supply of raw materials or semi-finished products;

5. Implementation of a new industrial organization or corporate restructuring

The economic long-wave analysis proposed by Freeman (1970) is based on Schumpeter's long wave theory and examines the long-run fluctuations of economic growth from the perspective of the relationship between technological innovation and

labor employment. He included the definition of innovation in a normative context, emphasizing business transformation. He believed that the rising stage of the long wave is driven by the development of new technologies or Emerging industries, and economic growth is built on enabling, funding and encouraging the invention and innovation of basic technologies. He emphasizes that innovation should start with top-level design, guided by long-term considerations, and focus on research and development issues. He then proposed in his paper *The economics of industrial innovation* that technological innovation means the first commercial transformation of new products, processes, systems and services.

Mansfield (1998) defines innovation from the technological perspective, stating that innovation is an exploratory activity in the development and manufacturing of new products, starts with the conception to the production and finally selling the product, and that new technology plays an important role in promoting new products.

Gary (2016) considers that in the existing technical environment, employees are able to develop their own creativity, and the company has the inherent order to cultivate employees' passion and imagination, and to motivate and manage them through a strict management style. The development of the company and creativity cannot be achieved without a perfect organizational structure. According to different productivity statuses and economic development statuses, corporate innovation is included in the general environment of national innovation. The state of economic and informational technology development in the 21st century has led to a change in the outreach of innovation, with the traditional techno-economic paradigm becoming an institutional-industrial paradigm,

a scientific-research paradigm, and an industrial-economic paradigm. Internet thinking has reshaped traditional thinking and broken the traditional organizational structure.

Types of Corporate Innovation. Enterprise innovation is the creation and innovation at all levels of business management for the production and operation of products that match the development trend of market demand, while continuously optimizing the allocation of its own and social resources. Innovation can be divided into three types: institutional innovation, technological innovation and managerial innovation (Daft, 1978; Damanpour et al., 1984; Kimberly & Evanisko, 1981).

Institutional Innovation

Institutional innovation refers to the introduction of new corporate institutional systems to replace the original one in order to adapt to the new situation or characteristics faced by the enterprise. The core of institutional innovation is the innovation of the property rights system, which is designed to maximize the enthusiasm of operators and employees. Only a reasonable corporate system can inspire the enthusiasm of all kinds of personnel and promote the development of technological innovation and management innovation.

Technological Innovation

Technological innovation refers to the introduction of a new method of production, which can be based on a new scientific discovery, a new way of operating a commodity for profit, or an innovation in the manufacturing process. The new production method refers specifically to the "revolutionary" change, or "mutation," in the entire material production process from input to output. This change is different from the small step adjustment year after year in the circular flow, including both hardware innovation such

as raw materials, energy, equipment and products, as well as software innovation such as process program design and operation method improvement. Among them, product innovation can be divided into novel products, new generation of products, improved products and imitation products according to the degree of innovation and improvement; process innovation can be divided into independent process innovation and dependent process innovation.

Management Innovation

Management innovation refers to the innovative activity of introducing new management elements (such as new management methods, tools, models, etc.) or combinations of these elements into the management system. It creates a new and more effective resource integration paradigm by making new qualitative and quantitative changes to various factors of production (human resources, material resources, technology) and functions (including production, marketing, etc.) of the company. This paradigm can be either new holistic management of effective integration of resources to achieve corporate goals and responsibilities, or new detailed management of specific resource integration and new goal setting, etc.

Corporate Innovation Characteristics. Innovation as a corporate development trait has many properties, Chinese and foreign scholars have proposed corporate innovation characteristics based on different analyses of corporate innovation behavior.

1. Creativity

The Creativity of innovation means that the activity carried out by innovation has significant progress compared with the activity carried out before, and innovation is mainly due to creative conception. Firstly, the creativity of innovation is mostly

importantly expressed in the fact that the technology it applies is a new and improved technology that has not been used before, and the application value is significantly improved; secondly, it is also expressed in the fact that the entrepreneur makes a new combination of production factors in the innovation process. On the other hand, the creativity of innovation is reflected in: i) new products, new processes or significant changes in products and processes; ii) changes in the organization, system and management.

2. Risk

Innovative activities involve many unknown factors, making the outcome uncertain. The proposal and implementation of an innovation is an act of decision-making, and all decisions inevitably have a certain degree of risk. At the same time, innovation, especially technological innovation, requires considerable investments, and whether these investments can successfully achieve value compensation is affected by many uncertainties, either from the technology itself, or from the market, society, and policy. A research report in the United States once asserted that, for every 10 patents in the United States, only 1 can become an innovation. The success rate of new product development in companies is only 20%-30%.

3. High return

The purpose of corporate innovation is to increase the economic and social benefits to the companies. Since innovation has high risks, and high risks co-exist with high benefits in economic activities, corporate innovation is highly beneficial. The most successful example of a company that has been able to capture high profit and growth through innovation is Microsoft. When Bill Gates founded Microsoft in 1975, there were

only three people in the company and the annual revenue was only USD 16,000. However, the continuous innovation of Bill Gates and others helped Microsoft grow into a high-tech giant that became popular all over the world and gained countless economic benefits. By 1995, its annual revenue was as high as USD 6 billion, and the profit achieved was more than the combined profit of the next ten software companies.

4. Systematicness and comprehensiveness

A company is a complex composed of many elements, and its production and operation process are composed of several links. Corporate innovation involves a series of systematic activities such as market research, forecasting, decision-making, R&D, design, installation, commissioning, management, marketing, etc. At the same time, corporate innovation is the result of collaboration. Innovation requires not only the adventurous spirit and organizational management ability of entrepreneurs, but also the theoretical knowledge and technology of scientific and technical personnel, as well as the close cooperation of specific implementers of innovation activities. Therefore, innovation is systematic and comprehensive.

5. Timeliness

The timeliness of innovation is first manifested in the process of product substitution, which can be caused by consumer preferences, changes or production technology updates. Therefore, product innovation is time-sensitive and is expressed in the timing of different innovation types. Since a new market demand is always firstly expressed as a product requirement, therefore, in the early stage of innovation, the innovation activities of companies are mainly on product innovation, followed by reducing production cost, improving quality and increasing production efficiency. At that

stage, companies will concentrate on process innovation. When the production reaches a certain scale, the innovation attention of the companies gradually shifts to the marketing innovation in order to increase the market share. The different timing of these innovation priorities will be accompanied by necessary organizational innovations.

6. Practicality

The innovation demand of the company must arise from when the internal or external environment of the company changes. In order to adapt to changes in the environment, innovation will enable the company to adapt to the new environment and promote its development and progress. Innovation is for development and progress, and only innovations that can really promote the development and progress of enterprises are innovations in the true sense.

Innovation Performance. When studying innovation performance, Chinese and foreign scholars usually define it as technological innovation performance, but this definition is quite vague. Foreign scholars often use the following indicators to measure the innovation performance of companies, such as the number of patents, R&D expenditure, total factor productivity, and the percentage of new product sales or sales volume; in addition, the measurement of innovation performance can also be based on the output of the innovative production process of companies. The contribution of innovation input to relevant indicators such as the output and efficiency of companies and industries can also be introduced.

Table 2-2 Common Innovation Performance Indicators

Source	Indicators for measuring innovation performance
Gemunden ,et al., 1996; Kleinknecht, 1999	Percentage of new product sales
Brouwer & Kleinknecht, 1999; Ahuja and Katila, 2001	Number of patents
Arundel & Kabla, 1998; Ahuja, 2000; Cooke& Clifton, 2002	Number of new products
Ritter, et al., 1999, 2002, 2003; Tsai, 2001	Speed of new product development
Hagedoom & Cloodt, 2003	R&D input; number of patent applications, number of patent citations

The main methods for evaluating innovation performance are:

1. Financial data research

Chinese and foreign scholars regard financial performance as the core of innovation performance study, and most of them evaluate it from the perspective of profitability and growth ability. Hsieh et al. (2003) found through their study that the profitability of investing in R&D projects is much higher than that of investing in fixed assets. Cheng et al. (2006) used financial indicators such as R&D intensity and profitability to measure the benefits and outcomes of R&D. Liang and Yan (2006) chose main business profit, average growth, intangible assets and technical assets to reflect the profitability, growth ability and core competitiveness of companies, and R&D expenditure and the number of technicians as the independent variables.

2. Comprehensive evaluation of indicators

The selection of relevant indicators of innovation performance in academia has gradually developed into a multi-dimensional comprehensive indicator system. In order to adapt to the current environment, scholars are continuously rectifying the deficiencies of the single financial indicator method, so that more scholars have turned to

comprehensive indicators to evaluate innovation, and the indicator system are being developed and improved continuously. Some scholars expressed the investment intensity of R&D expenditure as the ratio of R&D input to operating revenue (Chen and Liu, 2008). Other scholars divided the input, process and output indicators according to process characteristics. For example, Chen and Chen (2006) used the frequency of communication between R&D departments and users and the number of competition analysis reports as process indicators.

Theories Related to M&A and Corporate Innovation

Although M&A is recognized as an important part of a company's strategy, it is not usually associated with innovation. The literature on M&A focuses on the benefits of economies of scale and scope created by M&A on the one hand, and the costs of improving market position on the other (Burkart & Panunzi, 2008). However, experts who study innovation management have found that: due to the increasing complexity of innovation, the innovation activities of companies are increasingly dependent on external resources, and the promotion of innovation by means of M&A has drawn more attention. While a growing body of economics literature has noted the possible link between M&A and innovation, whether M&A can increase or decrease the innovation-related value and how to reallocate it remains an open question worth exploring.

The existing literature suggests several viewpoints that M&A can influence the innovation capability of companies in both a positive and negative manner. From the perspective of resource accumulation of companies, scholars held the idea that M&A can expand the knowledge and technology base of the acquirer, improve its technological capabilities and enhance its innovation level (Ahuja & Katila, 2001); the acquirer can

acquire valuable new knowledge and combine it with its own knowledge base to generate new innovations (Man & Duysters, 2005; Gerpott, 1995). From the perspective of economic benefits, the positive impact of M&A on innovation is expected to be based on economies of scale and scope (Cassimaneta, 2005). In addition, acquirers may also redeploy resources to improve their efficiency of resource utilization (Ahuja & Katila, 2001). The above positive effects can be summarized as meaning that M&A improves companies' innovation capabilities through "efficiency improvement".

On the other hand, in non-innovation-driven M&A (i.e., non-technology-driven M&A) deals, the main objective of the acquirer is financial funding or market dominance, and the resources it absorbs and integrates are used for activities other than innovation. Under these circumstances, M&A may reduce the R&D inputs and outputs, which is to the detriment of the innovation of companies (Hitt et al., 1991; Schenk, 2006). This effect can be summarized as "monopoly power". Research by Chinese scholars also supports this view, as Wen and Liu (2011) found that technology M&A of Chinese high-tech listed companies had a positive effect on the innovation performance of the acquirer, while non-technology M&A showed no significant effect.

As innovation-driven M&A has evolved in practice, traditional M&A theories have gradually become insufficient to explain related phenomenon. Therefore, related research on innovation-driven M&A has gradually increased. Malerba & Orsenigo (1999) stated that, in addition to the traditional drivers, another major factor contributing to M&A is knowledge transfer. Lehto & Lehtoranta (2004) proposed that part of the internal innovation of large companies can be realized by means of M&A, and acquisition of

high-tech companies to absorb advanced knowledge and technology can in turn complement internal R&D.

Knowledge Transfer Model of Innovation-Driven M&A. The knowledge transfer model aims to address the absorption as well as the effective use of new knowledge. Glazer (1991) argued that knowledge transfer through M&A is more economically efficient than knowledge creation by companies. Gho (2002) pointed out that companies should not be myopic in judging the success of knowledge transfer by profit indicators, and that knowledge transfer should be a top priority for companies to improve their organizational innovation capability. Prahalad & Hamel (1990) found that heterogeneous knowledge can determine a company's competitive ability and core edge. Therefore, companies can maximize the utility of knowledge assets by acquiring and assimilating external knowledge that has a positive effect on their development and converting it into organizational knowledge, so that the innovation performance of knowledge transfer can be demonstrated. Although scholars have different understanding of the knowledge transfer process, they all agree that knowledge transfer is beneficial to the innovation performance of companies.

The widely used knowledge transfer model at present was derived from the knowledge rotation model established by Nonaka & Takeuchi (1995), who pointed out that the key to knowledge transfer lies in knowledge creation, and that the process can be divided into five steps: (1) sharing tacit knowledge; (2) creating concepts; (3) proving the appropriateness of ideas; (4) establishing prototypes; and (5) expanding knowledge across levels. Through the continuous transformation and reorganization of tacit and

explicit knowledge, a virtuous circle of knowledge creation can be achieved, so that the innovation performance of the company can be improved.

In addition, Gilbert & Cordey (1996) believed that the knowledge transfer model can be decomposed into five stages: acquisition, communication, application, acceptance and assimilation, which can be understood from the communication theory and interpret mainly the process from initial acquisition to final internalization of knowledge.

According to the different models of knowledge transfer proposed by scholars, the knowledge transfer through innovation-driven M&A is mainly divided into two steps: knowledge acquisition and knowledge internalization. Knowledge acquisition emphasizes the acquisition of the knowledge base of the acquiree, while knowledge internalization means the process of absorption, digestion and re-creation of knowledge by the acquirer.

Effect of M&A on Innovation in China. Due to the shortened product life cycles and increasingly intense competition, it is often difficult for most SMEs to develop the resources and capabilities needed for innovation from within (Teece, 1987), and M&A allows these companies to access and utilize the quality resources of other companies to enhance their innovation capability. The main motivation for M&A activities in China stems from the value creation theory, where an important driving factor is synergy. Horizontal M&A brings economies of scale and scope, vertical M&A reduces transaction costs, and conglomerate M&A covers the first two and generates synergy (Weston et al., 1998). Market power is also a driver of value creation for companies through M&A. Horizontal, vertical, or conglomerate M&A can enhance the competitiveness of the acquiring company, strengthen barriers to entry, control market prices, and ultimately reap excess benefits (Zollo & Meter, 2008). Strategic factors cannot be ignored either.

Companies can quickly acquire strategic and scarce resources and quickly capture market shares through horizontal, vertical or conglomerate M&A (Chung & Alcacer, 2002; Shimizu, 2004). Since improving innovation is not the primary goal of the M&A activities in China, there are only a few studies at home and abroad that specifically investigate the impact of the M&A deals in China on innovation performance. Among them, Bertrand & Zuniga (2006) found that in medium technology-intensive industries in the Organization for Economic Cooperation and Development (OECD) countries, their domestic M&A events would lead to a reduction in R&D investment.

Theories Related to Absorptive Capacity and Corporate Innovation

The improvement effect of M&A on innovation capability depends on the learning effect and the absorption and transfer effect, while a company's ability to absorb and transform external knowledge and technology is an important aspect of the learning effect and the absorption and transfer effect, meaning that the absorptive capacity is the key to enhancing a company' technological skills. Therefore, a further literature review on the relationship between the absorptive capacity of companies and the improvement effect of M&A on innovation performance was carried out in this research.

Development Stages of Absorptive Capacity and M&A Innovation Performance. Cohen & Levinthal (1990) introduced the concepts of absorptive capacity and learning ability in their study of the role of R&D. They held the opinion that the R&D investment of companies not only promotes technological progress, but also enhances their ability to absorb, digest and imitate foreign technologies to innovate, thus enhancing their own innovation capability. They defined absorptive capacity as a company's ability to identify the value of new, external information and apply it for business purposes on the basis of absorption. Later, Zahra & Geroge (2002) considered the absorptive capacity of a company as a multidimensional structure and divided it into four dimensions: acquisition, absorption, transformation and utilization from the perspective of dynamic capacity.

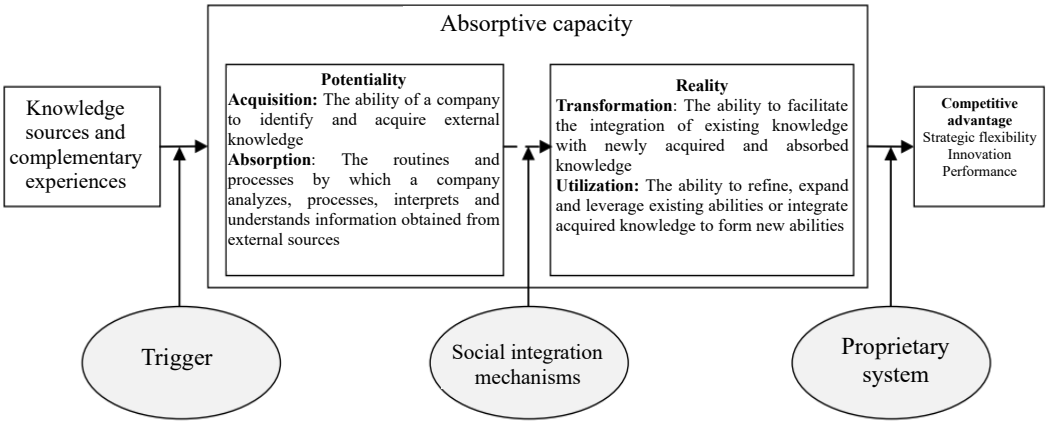

Figure 2-1 Zahra & Geroge's Absorptive Capacity (ACAP) Model

As more and more companies carry out investment activities and catch up in terms of innovation capability through the reverse knowledge spillover of investment, the study of corporate innovation capability has become a research paradigm for analyzing the catch-up of innovation capability. It is considered that the process of innovation

activities of acquirers is manifested as process innovation happening first, followed by product innovation. The technological development process of acquirers is divided into three stages: introduction, digestion and absorption, and improvement. To quickly improve their own technological innovation capability, acquirers often acquire mature innovative technologies by means of technology introduction. At this stage, acquirers do not improve their production processes, but carry out undifferentiated production. With the continuous accumulation of production technology, acquirers will gradually gain experience in product production and design, and accelerate the promotion of technologies. With the widespread dissemination and promotion of production technologies and products, the shrinking market share stimulates the acquirers to carry out technological improvement and process innovation. At this time, some of them will imitate and innovate based on market feedback, consumer demand and their own experience. Later, with the success of imitation-based innovation and the resulting increase in profits, the acquirers will pay growing attention to technological innovation and product innovation, and continuously increase their R&D investment in various technological innovation attempts. It can be found that acquirers first introduce mature technologies and processes, and then realize the improvement of technical capabilities through the continuous accumulation of technologies, and the acquisition of R&D innovation capability through imitation-based innovation (Kim, 1980).

Based on Kim's (1980) and Fan's (2004) studies, it is concluded that for Chinese companies, the process of realizing the improvement of R&D innovation capability through M&A can be divided into the following stages: simple technology acquisition and utilization; copying and imitation; imitation-based innovation; and upgrading

innovation. In each stage of improving R&D and innovation capabilities, different characteristics are shown in the development of companies. In the stage of technology acquisition and utilization, the technological capabilities of companies are generally low, and they can only make simple use of the technology and advanced knowledge acquired through M&A, without grasping the core know-how. The most typical example is the introduction of entire advanced production lines. Although the productivity of the company can be improved, once a middle link fails, it is often necessary to contact the manufacturer for later repair and maintenance. In the copying and imitation stage, due to insufficient knowledge accumulation, companies lack production experience and technical capabilities. Therefore, companies can "learn in practice" during the use of advanced technology and through informal communication and experience sharing to accumulate technologies and knowledge and improve their technological capabilities. In the imitation-based innovation stage, the absorptive capacity developed by companies in the previous stage will further affect their technological improvement. The companies that have entered this stage already have accumulated certain technologies and knowledge, and now they have sufficient funds and capabilities to realize the transfer and utilization of the technologies acquired through M&A, and to carry out certain imitation-based innovations with the acquired technologies. In the innovation stage, companies have accumulated greater technology and knowledge reserves compared with the previous two stages, so that they have stronger ability and more funds to carry out independent innovation and new product development. In the following section, the effect of absorptive capacity on the improvement of innovation performance through M&A in each stage of R&D innovation capability improvement will be analyzed.

The first is the simple technology acquisition and utilization stage, in which the acquirers simply use the technologies acquired from the acquirees. Thus, the theory involved is relatively simple, and the relationship between the acquirers' absorptive capacity, knowledge and technological accumulation is at the simplest and most basic level. In this dissertation, the relationship between the absorptive capacity and technological capability of companies in the copying and imitation stage, the imitation-based innovation stage and the upgrading innovation stage are discussed in detail. In the copying and imitation stage, the technological and knowledge level of companies are relatively low, and the absorptive capacity becomes the key factor for them to acquire external knowledge and technologies. In this stage, a company with higher absorptive capacity is more capable of controlling the external environment, and has greater opportunity to absorb the technologies and knowledge of the target company into its own. And through simple learning, copying and imitation, it is likely to achieve the production of similar products, increase its market share and weaken the strength of competitors. The accumulation of knowledge in the early stage, the communication and connection with the outside world, and the increase of investment in independent R&D and innovation can effectively enhance the absorptive capacity of companies, so as to realize the transformation and utilization of the technologies acquired through M&A.

In the imitation-based innovation stage, the absorptive capacity of companies is not limited to the digestion, absorption and learning of acquired technologies only. Companies should pay more attention to the accumulation of their own technologies and knowledge, and integrate the acquired technologies and knowledge with their own, and seek new market opportunities through the absorption of new technologies. Now since

companies have already gone through the copying and imitation stage, the technologies and knowledge accumulated in the early stage provide companies with certain R&D strength. As a result, when entering the imitation-based innovation stage, companies can improve their ability to absorb external technologies and knowledge by further strengthening their investment in R&D and innovation, which will help companies' internal technologies and knowledge sufficiently flow and diffuse fully, thus realizing more effective utilization and learning of advanced technologies acquired through M&A.

In the upgrading innovation stage, companies will focus more on the upgrading and integration of their technological capability, known as transformative capacity (Garud and Nayyar, 1994). They pointed out that the transformative capacity of companies is the ability to regroup and redefine resources based on the knowledge and technologies they possess, emphasizing the selection, maintenance and integration of their knowledge and technologies, and representing an advanced stage of the absorptive capacity of companies. When companies have certain transformative capacity, they will have the ability to transform and combine existing technologies and knowledge with immature technologies and knowledge (Fan, 2004), so that they can rapidly improve their technological capability. In this stage, the benchmark for companies to imitate and learn no longer exists, and the development of companies is mainly driven by continuous product innovation. In the upgrading innovation stage, the main purpose of M&A is to absorb the high-quality human resources, R&D elements, technologies and knowledge of the target company into the acquirer’s own product design and integrate them with its own product design or form innovative ideas and designs by absorbing external technologies and knowledge, thus continuously improving its technological capability.

Absorptive Capacity and Innovation Performance Improvement Through M&A. There are many ways for companies to improve their technological capability such as independent R&D innovation and technology introduction. The former often takes a long time. Moreover, as innovation requires certain human resources and involves high risks and uncertainties, it is difficult for companies with insufficient innovation motivation to achieve their technological capability quickly through independent innovation. Although technology introduction is quick in showing results, it often leads companies to path dependence. M&A provide an effective channel to improve the technological capability of companies. From the perspective of the cycle and risks of technology acquisition, the cycle of technology acquisition required for M&A is much lower than that for independent innovation. From the perspective of path dependence, M&A allows companies to achieve full control over the target company and is less likely to lead to path dependence. As China's economy enters a new normal stage, more and more companies are carrying out M&A activities in the context of industrial restructuring, transformation and upgrading. Wu and Su (2014) pointed out that a growing number of companies not only focused on the immediate return on investment during M&A, but also sought the acquisition of the technologies, resources and brands of their targets through M&A to achieve long-term development. This means that a large number of companies are using M&A as a lever to achieve ability upgrading and technological catch-up through M&A, and more companies have caught up with and even surpassed the leaders. However, the effect of M&A on technological capability improvement depends on the absorptive capacity of companies (Xiao and Xie, 2016). In fact, what companies acquire through M&A is usually explicit knowledge, but what can really promote the

technological capability improvement of companies is the tacit knowledge hidden behind the explicit knowledge, and the acquisition of tacit knowledge depends on the absorptive capacity of companies. It can be found that the main reason why M&A has different effects on the R&D and innovation capabilities of companies is that the absorptive capacity of different companies is significantly different. Companies with high absorptive capacity can digest, absorb and re-innovate advanced technologies, thereby improving their technical capabilities; and for companies with low absorptive capacity, instead of effectively absorbing and transforming the acquired advanced technologies and promoting the improvement of technological capabilities, they may fall into the deadly cycle of "introduction - lagging behind - reintroduction - lagging behind again".

Although absorptive capacity represents the ability of a company to identify, evaluate and use external information, it does not necessarily mean that the higher absorptive capacity, the better. In fact, the increase in absorptive capacity represents the efforts made by the company to maintain a high level of absorptive capacity, but sometimes the efforts do not pay off accordingly. For a company, only when its absorptive capacity exceeds a certain threshold can it make better use of the advanced technologies, knowledge and management experience acquired through M&A, thereby promoting the improvement of its technological capability; on the contrary, when a company's absorptive capacity is lower than the threshold value for digestion and absorption, not only will it fail to effectively absorb the technologies and innovative achievements acquired through M&A and thereby improve its technological capability, but it may also rely on foreign technologies and fall into the infinite cycle of

"M&A-acquisition of achievements –M&A -acquisition of achievements", and fail to develop its own innovation capability.

However, not all companies can effectively absorb the technologies and knowledge acquired through M&A. This process depends not only on the nature of the companies but also on their motivation for M&A. In terms of the nature of companies, the differences in policy support and financing constraints among companies of different nature lead to certain differences in the technology acquisition abilities of acquirers from target companies. For example, many studies have shown that the government has a significant influence on the M&A decisions of companies. Due to the resource effect of state-owned equity, it provides great resource support and policy support for the M&A of state-owned companies, which helps companies reach the minimum threshold of absorptive capacity and thus achieve technological capability improvement. In addition, from the perspective of M&A motivation, in the context of industrial structure transformation and upgrading, the government has given more support and policy preference to technology-seeking M&A, which is more conducive to technology acquisition and capability enhancement through absorption by companies.

Through the review of the existing studies on investment and reverse knowledge acquisition of companies, it can be found that domestic and foreign scholars have not reached a consensus on this proposition, because the absorptive capacity of different acquirers varies. The lack of absorptive capacity will lead to the failure of the company's investment to achieve its strategic goals because 1) insufficient absorptive capacity will lead to the inability of subsidiaries to efficiently acquire the knowledge resources of the parent company; 2) suitable channels for transferring intellectual resources between the

parent company and its subsidiaries cannot be formed; and 3) it restricts the parent company from learning and imitating the transferred knowledge (Li and Liu, 2012). Among the studies on factors influencing technology diffusion, parent company's human resources and R&D expenditure are considered to be the two most important influencing factors, both of which are associated with the absorptive capacity that parent companies have to acquire foreign technologies. Nelson and Phelps (1966) and Cohen and Levinthal (1989) pointed out that R&D investment and human resources are the key elements for companies to acquire external technologies, because companies' own R&D efforts can help them identify and assess external innovation trends. In a study of human resources and technology transfer, Bartel and Lichtenberg (1987) pointed out that human resources are conducive to the acquisition of new technologies in a closed economy environment. In addition, some scholars have also examined the relationship between absorptive capacity characterized by R&D investment and knowledge diffusion. For example, Griffith et al. (2000), in their study of the determinants of productivity dynamics in 12 OECD countries from 1974 to 1990, found that the higher the growth rate of a country's industry, the greater its R&D expenditure. This finding that indirectly suggests the importance of R&D expenditure for external technology acquisition.

Keller (2004) stated that whether absorptive capacity reduces the knowledge gap or further exacerbates the differences for knowledge transfer depends on the distribution of absorptive capacity. On the one hand, when the parent company has weak absorptive capacity, it may not be able to effectively absorb the transferred knowledge and technologies, thus further exacerbating the technology gap; on the other hand, if the parent company has strong absorptive capacity, on top of absorbing the transferred

knowledge, it will also conduct imitation-based innovation or even independent innovation, which will continuously narrow the gap between them with technology leaders, and even surpass the benchmark companies to become the industry leader. A few scholars have discussed the M&A's effect on improving technological innovation capability from the perspective of absorptive capacity. For example, Wang et al. (2014) found that absorptive capacity is a key factor affecting the equilibrium of evolutionary game by establishing an evolutionary game model of technological M&A knowledge sharing, and that the stronger the absorptive capacity, the better the technological innovation performance of a company.

Literature Review

With the development of China's economy, the M&A market has become increasingly active as more companies are involved in M&A. Both domestic and cross-border M&A are developing rapidly. Companies can achieve expansion and development through M&A. M&A transactions in China are mainly horizontal and vertical mergers to develop markets, acquire strategic resources, and optimize production allocation, thereby reducing costs, increasing profits, and achieving the goal of improving overall profitability. In recent years, there have been M&A cases seeking to acquire advanced technologies to enhance the core competitiveness of companies in China.

Innovation is the key to national progress and the driving force of national development. The innovation capability of a country's companies is crucial to the prosperity of the country. The accumulation of knowledge base is the key to improving the innovation level. Companies mainly acquire knowledge and technologies in two ways: internal R&D and external acquisition. However, companies conducting internal R&D

may easily fall into the trap of path dependence, and it may cost more time and money, while external acquisition is more targeted and can help companies quickly expand their knowledge base and develop their innovation capability. For Chinese companies that are at a disadvantageous position in competition and at the bottom of the global value chain, innovation capability is critical to their survival and is an important foothold for companies to stand in a competitive environment domestically and internationally. According to the theory of knowledge transfer, companies can acquire the required knowledge quickly through M&A and combine it with their own knowledge base after effective absorption, so that it can play a complementary and synergistic role to enhance the technological strength of companies, thus improving their innovation level.

In recent years, more scholars have studied the relationship between M&A and innovation. The existing literature shows different opinions on the impact of M&A on innovation, and it is impossible to determine whether M&A can promote innovation. Moreover, researchers' analysis of the effect of M&A on innovation is limited to a simple distinction between technology-driven and non-technology-driven M&A, ignoring the complexity and diversity of M&A motivations in reality. Furthermore, China, the largest developing country, is in an important stage of economic transformation, and its national conditions are unique. Only a few related studies have been done in China with a small sample size. This research is innovative and meaningful as 1476 M&A events were taken as samples to analyze the impact of M&A on corporate innovation from the perspective of M&A and innovation based on the data of 3,373 listed companies in China from 2007 to 2016.

Meanwhile, we can find through the previous analysis that companies can directly acquire explicit assets such as advanced technologies, marketing channels, and resources of target companies through M&A. However, due to the inherent nature of knowledge, not all knowledge can be transferred and digested after M&A. Generally, although the transfer of knowledge such as patents and technologies of the merged company can be realized through M&A, the transformation of companies from the stage of "learning-imitation-independent innovation" depends on their absorptive capacity.

The following shortcomings were found through the literature review: (1) At present, the studies on the effect of M&A on innovation are mostly carried out in developed countries, and the findings of foreign studies are not necessarily applicable to Chinese companies due to the late emergence of M&A in China and the different development environments of Chinese companies and industries; (2) Most of the previous studies on technology M&A and innovation performance selected a single indicator to investigate its role at the knowledge level, and few studies explored the complete process of transforming knowledge into innovation performance in M&A; and (3) Although domestic scholars have done a lot of studies on the M&A performance of Chinese companies, most of them focused on the economic benefits of M&A and the productivity of companies, with less attention to whether M&A has improved the innovation performance of companies. Therefore, it is necessary to explore the effect of M&A on innovation in the context of the actual development of Chinese companies and industries, and the process of absorptive capacity influencing innovation performance in M&A.

CHAPTER III

PATENT-RELATED CONCEPTS AND DEVELOPMENT STATUS

Patent-Related Concepts

Patent Concept and Classification Criteria. A patent is an invention protected by law. It refers to the exclusive right to the invention that is granted to the patent applicant valid for a specified period of time after the patent application is submitted to, and approved by the relevant national authority. Technology is the essence of a patent, and the quality of an invention is the technical level of the patent. Specifically, the technical level of an invention can be considered from two perspectives: the width of the technology, i.e., the span of the technical field covered by the technology; and the height of the technology, i.e., the difficulty of the R&D of the technology, and the position of the technology among frontier and cutting-edge counterparts. The wider the technical field covered by an invention, the more it is at the frontier of science. The technical level of such invention is undoubtedly high. It is worth noting that the statutory patent authorization standards determined by the Patent Law are essentially the minimum technical requirements for a patentable invention to be granted. A patent may be granted only when the technical level of an invention is equal to or higher than that stipulated by the Patent Law. The technical level of the invention itself is fundamentally determined by the R&D and innovation capabilities of the developer.

According to different classification criteria, there are various forms of patent classification. The types of patents vary in the legal systems of different countries and regions. For example, the Chinese Patent Law stipulates that the patent types include invention, utility model and design patent; the Japanese Patent Act stipulates that patents are divided into patents, utility models, and industrial designs; and the US Patent Act

classifies patents into utility patents, plant patents and design patents. According to the degree of influence, there are important patents and general patents, and important patents can be subdivided into core patents and non-core patents. According to the life cycle of a single patent, the patent life cycle consists of the conception, formation, examination and enforcement stages. The life cycle of a patent is closely related to its legal status, and in China, there are five types of legal status: pending, valid, invalid, technology transformation and other.

In this research, the classification criteria stipulated by Chinese law were adopted to divide patents into invention, utility model and design patents. China's Patent Law defines an invention as " a new technical solution proposed for a product, method or the improvement thereof that can result in a product with independent intellectual property rights." Therefore, inventions demonstrate the level of innovation best. A utility model is defined as: "a new technical solution developed for the shape, structure or combination thereof of a product that is suitable for practical use." A design is defined as: "a new design of a product's shape, pattern or combination thereof, or the combination of its color and shape and pattern, which is aesthetically appealing and industrially applicable." Generally, utility model and design patents are less innovative than invention patents.

China's Patent Development Plan. The Patent Development Plan is a guiding document for the development of China's patent sector. The Patent Development Plan published usually includes the guiding principles, expected targets and guarantee measures for patent development. The Patent Development Plan usually specifies the expected targets of patent growth in a quantitative manner. This subsection will analyze the expected targets of patent growth proposed in the Patent Development Plan.

Table 3-1 Quantitative Targets in National Patent Development Plan 35[1]

Date of publication	Policy document	Main targets and tasks
2001	"Tenth Five-Year" Plan for National Patent Work	The average annual growth rate of patent applications reaches about 14%, and the total number of patent applications exceeds 300,000 in 2005.
2006	*Outline of the National Medium- and Long-term Scientific and Technological Development Plan (2006-2020)*	The number of invention patents stands in the top five in the world's patent grant ranking.
2013	*Opinions on Strengthening the Dominant Position of Corporate Technology Innovation to Comprehensively Enhance Corporate Innovation Capability*	In 2015, the total number of invention patent applications and patents granted of large and medium-sized industrial companies doubles at least.
2015	*Action Plan for the Further Implementation of the National Intellectual Property Strategy (2014-2020)*	The number of invention patents per million people reaches 6 by 2015, with an average maintenance period of 6.4 years, and 14 by 2020, with an average maintenance period of 9 years.

[1] Source: Development Plan published by the China National Intellectual Property Administration

Table 3-1 Quantitative Targets in National Patent Development Plan 35[2](Continue)

Date of publication	Policy document	Main targets and tasks
2017	*"Thirteenth Five-Year Plan" for National Technology Innovation Project*	The number of invention patents and the number of PCT patent applications of companies doubles.
2020	*Annual Working Guidelines for Promoting High-Quality Development of Intellectual Property (2019)*	The new investment of intellectual property operation funds in key industries grows by more than 50%, the amount of intellectual property insurance coverage increases by more than 20%, and the amount of patent and trademark pledge financing rises by at least 10%.
2021	*Outline for the Construction of a Strong Intellectual Property State (2021-2035)*	By 2025, the added value of patent-intensive industries accounts for 13% of GDP, and that of copyright industries accounts for 7.5%; the annual import and export volume of intellectual property royalties reaches RMB 350 billion; and the number of high-value invention patents per 10,000 people reaches 12

Table 3-1 lists the provisions on the expected targets of patent growth in the Patent Development Plan issued by China. Through a detailed analysis of the contents of Table 3-1, we can draw the changing trend of the priorities in China's Patent Development Plan. The target of patent development in the Patent Development Plan is to achieve rapid growth in the number of three types of patents before 2006, and to promote the growth of invention patents after 2006. The newly added indicators listed in the Patent Development Plan are the number of invention patents per million people, the number of PCT patent applications and the number of years of patent maintenance. The change of the targets shows that China expects not only quantitative growth in the development of patent business, but also the quality of patents.

[2] Source: Development Plan published by the China National Intellectual Property Administration

Among the three different types of patents, invention patents are more innovative, represent higher technical content, and can create more additional benefits for companies. However, China's current patent structure is unreasonable and imperfect as the proportion of invention patents is relatively low, with less high-quality patents. The Patent Development Plan quantifies the number of invention patents per million people and the number of PCT patent applications, indicating that the government has changed the goal from achieving the growth of the three types of patents to pursuing the increase in the number of invention patents. This change will promote the rapid growth of high-quality and high-value patents, reduce low-quality junk patents, improve the existing patent structure, enable more patent inventions to create economic benefits for companies, and realize the transformation of patent development focus from "quantity" to "quality".

The maintenance life of a patent is an important index to measure the value of the patent. In China, it is mostly 3-6 years, while in foreign countries, it can be as long as 6-10 years, much longer than that in China. Under the guidance of the early plan focusing on the growth of the total quantity of patents, many of the patents granted during the "explosive growth" period are design patents and utility model patents that lack technological innovation. The market conversion rate of these two types is low, and the economic benefits they created for companies may not be able to cover the annual fees payable by companies for continuing to hold the patents. As a result, companies may abandon the patents, resulting in a generally short patent maintenance life.

Status Quo of Patent Development in China

In this research, the number of patent applications and authorizations in China from 2002 to 2020 from the China National Intellectual Property Administration was

collected and compiled for study and analysis. This chapter begins with an analysis of the trend of changes in the number of patent applications and the percentage of invention patent applications in China, follow by an examination of the trend of changes in the number of patents granted and the percentage of invention patents granted in China.

Trend of Changes in Number of Patent Applications Received in China

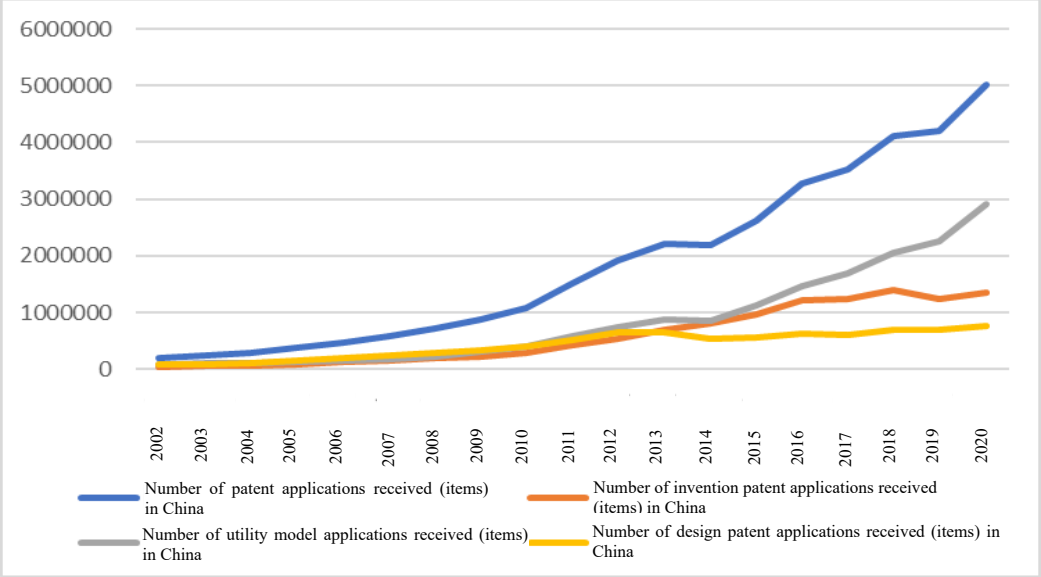

Figure 3-1 Changes in Number of Patent Applications Received in China (2002-2020)

The trend of changes in the total number of patent applications in China is shown in Figure 3-1. We can conclude that between 2002 and 2020, the total number of patent applications received in China shows a rising trend. The number rose from 205,544 in 2002 to 501,630 in 2020. Among the three types of patent applications, the number of utility model patent applications has always been the largest since 2011. Specifically, the number of invention patent applications increased from 39,806 in 2002 to 1,344,817 in 2020, increasing by 32.78 times. The number of invention patent applications saw the greatest growth of 42.61% in 2003, which was also the largest among the three types of

patent applications; the growth of invention patent applications slowed down significantly since 2017 to about 10% only. The number of utility model patent applications increased from 92,166 in 2002 to 2,918,874 in 2020, increasing by 30.67 times. The number of design patent applications increased from 73,572 in 2002 to 2,918,874 in 2020, increasing by 9.23 times, which was the smallest growth among the three types of patent applications, and the increase in the number of utility patent applications was slightly larger than that of invention patents.

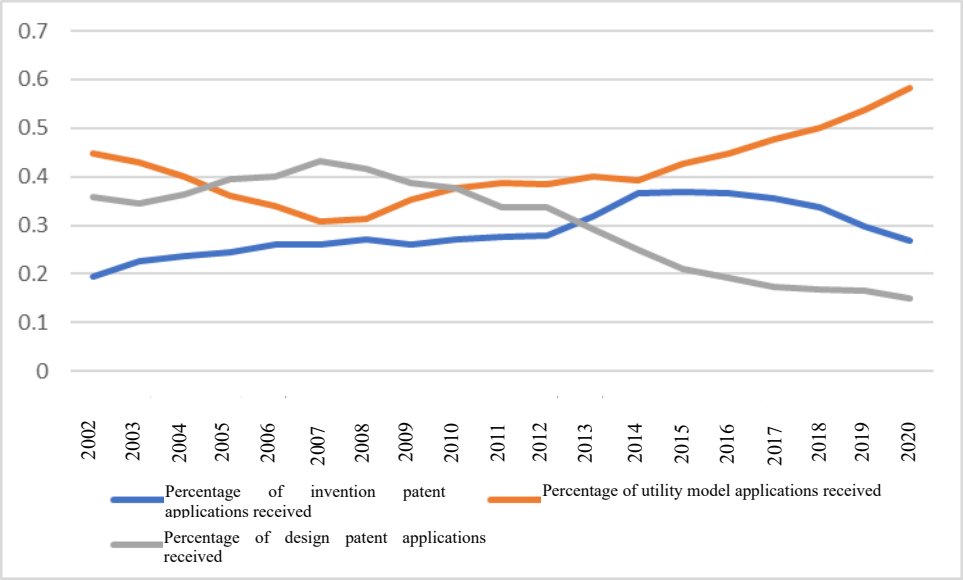

Figure 3-2 Changes in Percentage of Three Types of Patent Applications Received in China (2002-2020)

The trend of changes in the percentage of invention patent applications by listed companies in China is shown in Figure 3-2. We can conclude that from 2010 to 2020, the percentage of utility model patent applications is the largest in the total number of three types of patent applications, showing a decreasing-increasing trend, with the highest percentage being 58.19% in 2020. The percentage of invention patents shows an increasing-decreasing trend, with the highest percentage being 37.00% in 2015, after

which the proportion declined continuously. Since 2007, the percentage of design patents with the lowest technical content has generally shown a downward trend, decreasing from 43.21% in 2007 to 15.00% in 2020. In general, since 2007, the percentage of utility model patents has been increasing, that of design patents has been decreasing, and that of invention patents has been increasing first and decreasing later. It shows that the structure and proportions of patent applications in China are becoming increasingly reasonable, and the quality of patent application is constantly improving. However, the number of applications for invention patents with the highest technical content is not optimistic.

Trend of Changes in Number of Patent Authorizations in China

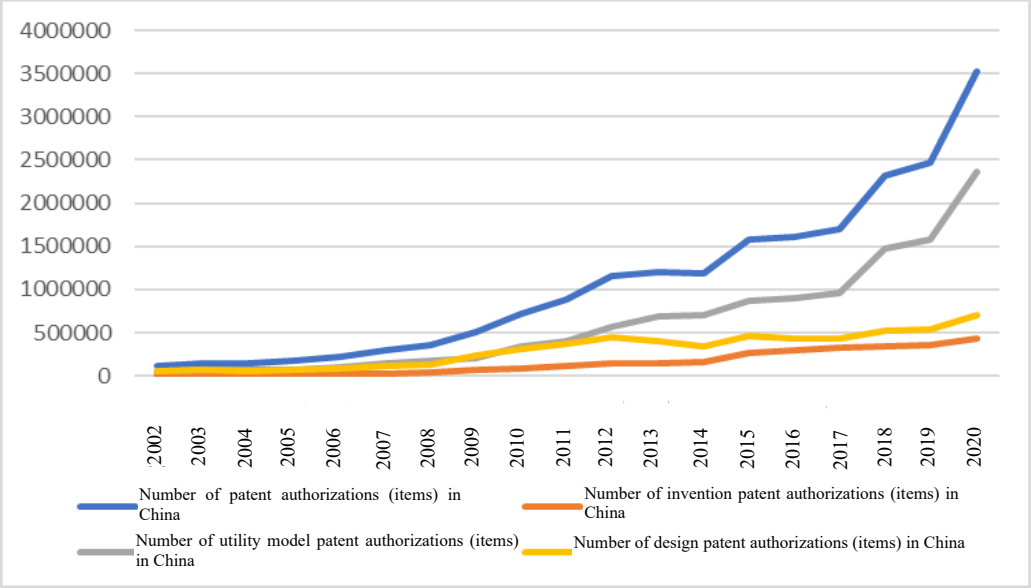

Figure 3-3 Changes in Number of Three Types of Patent Authorizations in China (2002-2020)

The trend of changes in the total number of patent authorizations in China is shown in Figure 3-3. We can conclude that between 2002 and 2020, the total number of patent authorizations in China shows a rising trend. The total number of patent authorizations has increased from 112,103 in 2002 to 3,520,901 in 2020, increasing by

3,408,798. The number of invention patent authorizations has increased from 5,868 in 2002 to 440,691 in 2020, increasing by 74.10 times and representing the largest increase among the three types of patent authorizations. The number of utility model patent authorizations has increased from 57,092 in 2002 to 2,368,651 in 2020, seeing an increase of 40.49 times. The number of design patent authorizations has increased from 49,143 in 2002 to 711,559 in 2020, seeing an increase of 13.48 times, which is the smallest among the three types of patent authorizations. Among the three types of patents, the number of utility model patent authorizations has always been the largest. However, under the guidance of changes in the patent policy orientation, companies are more inclined to apply for invention patents with higher value, and the number of invention patent authorizations has increased. The gap between the number of invention patent authorizations and that of utility model authorizations narrowed before 2017, but widened thereafter.

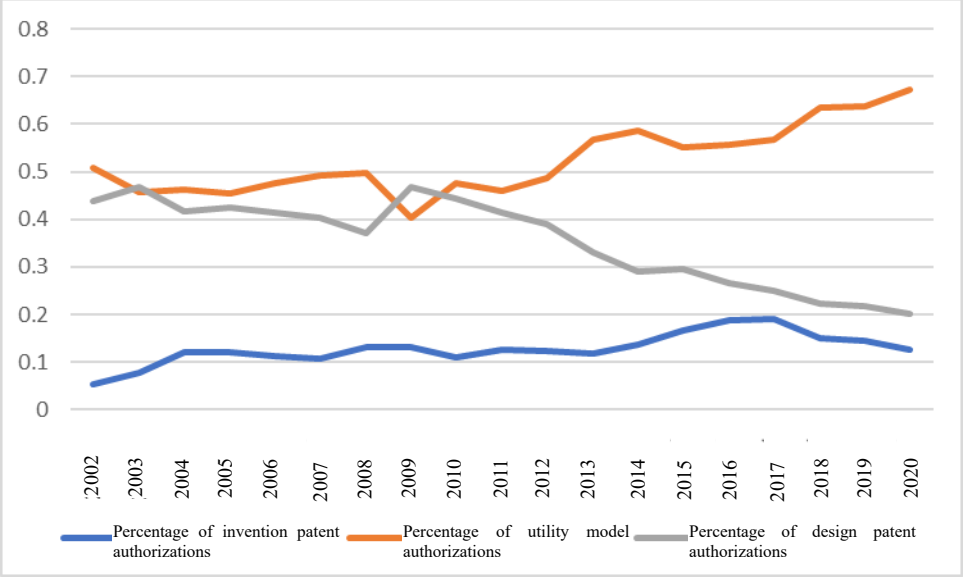

Figure 3-4 Changes in Percentage of Three Types of Patent Authorizations in China (2002-2020)

The trend of changes in the percentage of invention patent authorizations in China is shown in Figure 3-4. We can conclude that from 2002 to 2020, except for a few years, the percentage of utility model patent authorizations in the total number of three types of patent authorizations has always been the largest, with the highest being 67.27% in 2020. The percentage of utility model patent authorizations decreased significantly in 2009, accounting for 40.28%, but began to increase year by year from 2009 to 2020. From 2002 to 2017, the percentage of invention patent authorizations showed an overall upward trend amid fluctuations. The lowest percentage of invention patent authorizations appeared in 2002, at only 5.23%. But in 2017, that percentage rose to 19.18%, and its gap with the percentage of utility model patent authorizations also narrowed. The percentage of design patents, which has the lowest technical content, has been decreasing significantly, from 46.69% in 2009 to 20.21% in 2020. In general, the percentage of invention patents had been increasing from 2002 to 2017 but declined slightly in the later years. The overall proportion of utility model patent authorizations fluctuated upward, while the proportion of design patent authorizations fluctuated downward, indicating that the structure and proportions of granted patents in China is becoming reasonable and the quality of the granted patents is constantly improving.

CHAPTER IV

EMPIRICAL RESEARCH ON THE IMPACT OF M&A TRANSACTION SIZE ON CORPORATE INNOVATION PERFORMANCE

Research Hypotheses

The Relationship Between M&A Transaction Size and Innovation Performance. In the background of economic globalization and innovation-driven development model, market competition has become increasingly fierce and the speed of technological renewal has further accelerated. Therefore, it is necessary to improve the innovative performance of companies. The company's own resources are limited, and most of them are distributed among different companies, so it is not enough to rely only on the company's own internal resources, but also need to consider acquiring high-quality knowledge and technology and other resources from other companies externally to improve the company's innovation capability. M&A is one of the most important ways for companies to acquire external resources and technologies.

According to previous studies, M&A can adjust the organizational structure and development strategy and redefine the growth path of companies (Cassiman et al., 2005). Therefore, M&A plays a crucial role in reallocating a company's resources. M&A allows a company to quickly acquire the knowledge base and technical assets of another company, such as patents and the R&D team of the target company, and to combine its own resources to fully exploit the technological advantages of the company for innovation, changing its innovation method and level.

Based on the theories of industrial organization and value transfer, M&A may affect the innovation path of companies both positively and negatively. On the one hand, M&A allows companies to better utilize the advantages of economies of scope and scale

to enhance innovation efficiency. and motivates them to pay attention to R&D while improving their innovation capability. On the other hand, the monopoly power and financial leverage that M&A may bring will weaken the motivation of enterprises for R&D and innovation, affecting their innovation negatively. Zhang (2019) studied the corporate innovation activities of Chinese listed companies and found that M&A activities in China can generally bring great benefits from economies of scale and enhance the monopoly power of companies. Low-level competition prolongs the product replacement cycle, leading to companies' reduction of innovation investment. Due to the proximity between the technological levels of the two parties in M&A in China, the "efficiency improvement" effect is relatively small, while the "monopoly power" effect is more obvious.

To sum up, the changes in innovation decision-making depend on the interaction between the positive and negative effects of "efficiency improvement" and "monopoly power". For M&A, especially technology-driven M&A, large differences between the acquirer and the acquiree can often bring about greater efficiency improvement and incentives for companies to increase innovation activities and R&D investment. At the same time, the M&A acquirers are mainly companies with relatively stronger market power in China that can obtain a larger market share in the local market. Therefore, domestic M&A often leads to the enhancement of monopoly power, which will in turn result in the insufficient attention of the management of companies to innovation activities. The size of an M&A transaction is the expense of the acquiring the target company. This expenditure is an important dimension in examining the characteristics of an M&A transaction. The size of M&A transactions can have a significant impact on

company resources and management risk perceptions, and thus on overall corporate innovative performance.

In this regard, two hypotheses are proposed here.

Hypothesis 1: Bigger M&A transactions will occupy resources that could have been invested in innovation activities, thus making it difficult for companies to start innovation.

Hypothesis 2: Bigger M&A transactions will stimulate the innovation vitality of the acquirers, activating their innovation activities and triggering an increase in innovation output.

Moderating Effect of Absorptive Capacity of Companies. Core technologies usually need to be acquired during the R&D process. Acquirers acquire the most core technologies of acquirees by improving their absorptive capacity and organizing the learning process, laying a knowledge foundation for the improvement of their own innovation capability. Therefore, in the M&A events with the primary purpose of acquiring high-quality resources and advanced technologies, how to absorb, digest and apply the technologies and knowledge of the target companies by improving the absorptive capacity is the key to the success of the M&A, which will help companies to complete the effective integration and absorption of the technologies and knowledge of the target companies after the M&A.

Absorptive capacity is one of the most important factors affecting innovation performance of companies and is also a key factor determining the success of post-M&A integration and performance improvement. Based on the resource-based theory: corporate resources are all the assets, corporate identity, information, knowledge, and other

elements that a company has the right to freely control and use to build and implement strategy (Daft, 1983). If resources are to provide enterprises with sustainable competitiveness, these resources are often scarce, valuable, incompletely imitative, and irreplaceable (Barney, 1991). Companies have the opportunity to gain access to other non-profit resources through M&A, such as senior talent and R&D resources. On the basis of acquiring resources, improving the absorptive capacity of companies through cooperation can be a driving force to improve their technological innovation level.

Based on organizational learning theory: Argyris and Schön (1978) considered that organizational learning is a process in which an organization effectively handles information related to internal differences and improves organizational behavior. The key to developing and maintaining a competitive advantage in a continuous learning process must be technological learning. Acquirers can directly obtain and use some complementary knowledge of the acquirees in M&A, and improve their own innovation capability through learning, integration, absorption and utilization. In addition, enhancing absorptive capacity can also promote the sharing of experience between technical personnel from both sides, enabling acquirers to master core R&D technologies in a short period of time (Wang, 2013).

Absorptive capacity refers to a company's ability to identify and absorb valuable information and transform it into wealth (Kim, 1998). Acquirers need to enhance their absorptive capacity to complete a series of processes such as the transformation and utilization of external knowledge, which will in turn promote technological innovation. Absorptive capacity also affects the enthusiasm of companies for innovation. The greater absorptive capacity, the more accurately companies can identify and utilize high-quality

new knowledge resources, and the stronger motive they may have to initiate innovation activities (Cai, 2014).

The analysis above shows that, on the one hand, if the transaction size of M&A is large, the resources that could have been invested in corporate innovation activities will be taken up by the M&A, but the higher absorptive capacity of acquirers can enhance the utilization of resources and reduce the occupation of resources. This to some extent weakens the negative effect of M&A transaction size on innovation performance. On the other hand, stronger absorptive capacity can, to some extent, maintain the confidence of companies in R&D and partially offset the uncertainty caused by large-scale M&A, thus enhancing the positive effect of M&A size on acquirers' innovation performance.

Accordingly, the following hypothesis is proposed:

Hypothesis 3: The negative effect of M&A transaction size on innovation performance decreases with the enhancement of absorptive capacity.

Hypothesis 4: The positive effect of M&A transaction size on innovation performance increases with the enhancement of absorptive capacity.

Variable Description and Model Setting

Variable Description. Response variables: total number of patent applications (AplSum), number of invention patent applications (AplInv), number of utility model patent applications (AplPra), number of design patent applications (AplDes), total number of patent authorizations (AutSum), number of invention patent authorizations (AutInv), number of utility model patent authorizations (AutPra), number of design patent authorizations (AutDes). In this dissertation, we reviewed the literature of Chinese and foreign scholars, and the measurement of innovation performance is generally measured from input and output dimensions. Input indicators include the number of enterprise R&D personnel and the amount of R&D investment, while output indicators include the number of patent applications, the number of new product R&D, and the sales of new products, etc. Since this dissertation studies the relationship between M&As of pharmaceutical companies and the company's innovation performance, we focused more on the result of the company's innovation output, so the explained variables in this dissertation are not considered as the input. On the other hand, when measuring the output, the number of new products developed by the company is not considered because it is difficult to define what is "new" and the number of new products sold by the company is subject to market fluctuations. Therefore, the quantities of patents were selected as the response variables in this dissertation. The approach used by Li (2020) in one of the references was selected to represent innovation by the number of patents, specifically the number of patent applications and patent authorizations during 2008-2017 from the CSMAR database. The numbers are the combined values of the parent companies and affiliates, with missing values neglected. The variables related to patent

authorizations were set because the vast majority of patent applications can be authorized or denied within four years. On this basis, further breakdowns were made according to patent classification (invention patents, utility model patents and design patents). Considering that there is a certain time lag in patent applications, the natural logarithm of the number of patent applications and authorizations in one year after the M&A plus one was taken as the innovation performance measure in this dissertation, and the data was obtained from the patent search website of the China National Intellectual Property Administration.

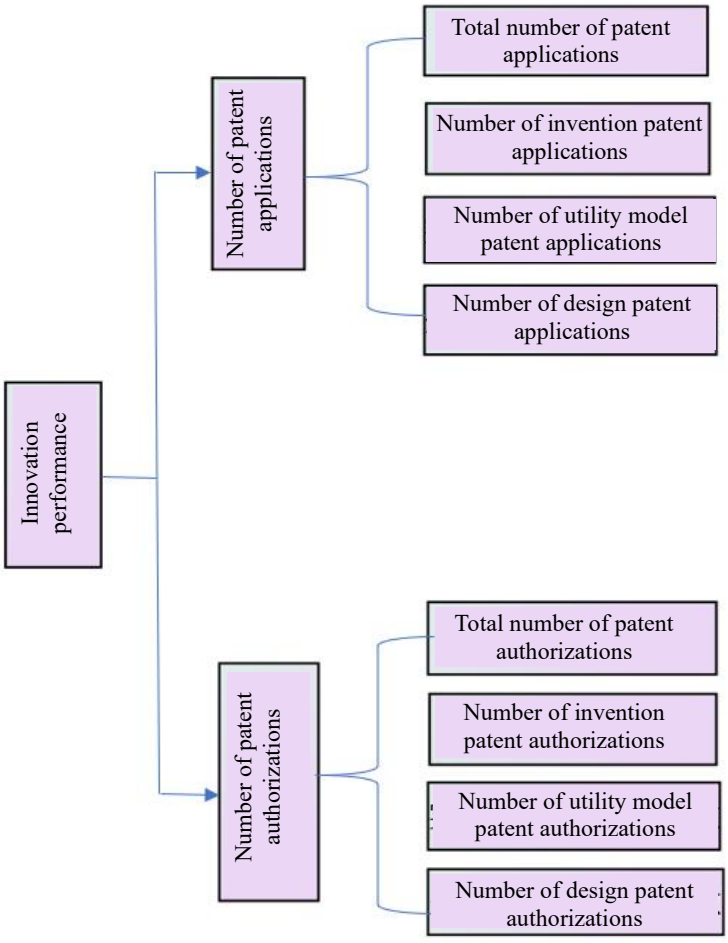

Figure 4-1 Description of Innovation Performance Variables

Explanatory variables: In this dissertation, the size of M&A transactions of listed companies from 2008 to 2017 in the CSMAR database was taken as an explanatory variable to reflect the characteristics of M&A acquirers. M&A deal size (Scal) is an important dimension to examine the characteristics of M&A deals. Previously, scholars have used the relative size of M&A as a measure, i.e., the amount of M&A transactions as a proportion of the company's total assets. Since the total asset of each company varies greatly and there are uncertainties affecting the value of total asset every year, there are uncertainties in using total assets as the base to measure the share of M&A transaction amount, so this dissertation directly adopts the absolute scale of M&A, which is expressed as the natural logarithm of M&A transaction amount. If a company was engaged in multiple M&A transactions within a year, the amounts were added up to get 281 transaction records. Then the M&A data of transactions with incomplete information will be supplemented to 0, and the relevant data won't participate in the empirical analysis process. Finally, the M&A data was sorted into a panel of 58 companies from 2008 to 2017. Specific descriptive information is shown in the following table.

Table 4-1 Descriptive Analysis of M&A Transaction Information

Year	Total amount of M&A transactions (RMB 100 million)	Number of M&A transactions	Number of transactions with incomplete information	Minimum value of M&A transactions (RMB 100 million)	Maximum value of M&A transactions (RMB 100 million)
2008	4.57	9	0	0.06	1.56
2009	8.32	19	0	0.17	2.02
2010	11.09	21	2	0.01	2.13
2011	16.63	24	3	1.02	2.49
2012	18.92	28	2	0.01	2.57
2013	35.69	31	0	0.31	5.71
2014	64.55	33	0	0.14	18.07
2015	119.67	37	0	0.00	14.34
2016	222.25	38	5	0.05	38.01
2017	387.82	41	3	0.24	44.25

Moderating variable: absorptive capacity (Res). Drawing on the research of Xiao and Xie (2016), the dimension of human resources was selected in this dissertation to measure the absorptive capacity of a company. Specifically, the proportion of the number of R&D personnel to the total employees of the company was taken as a proxy variable for the absorptive capacity of a company from public company earnings reports. People are an important source for the improvement of technological capability of companies. The absorption and digestion of knowledge as well as the output of innovative knowledge depend on the human resources of companies. A large number of studies pointed out that technology transfer and knowledge sharing need to be carried out by people, while human resources also play an essential part in integrating the knowledge and technology spilled over from the acquired companies into their own knowledge and technology systems and transforming them into new products and technologies.

Control variable: Based on previous studies, the following control variables are considered in this dissertation: company size (Size), the company's age (Age), profitability (ROA), operating capacity (Turo), and solvency (Debt).

Company size (Size) is the natural logarithm of a company's total assets at the end of the year. To achieve economies of scale is the motivation for M&A of most existing pharmaceutical companies. Companies can acquire the needed superior resources through M&A, and at the same time integrate the resources to expand their scale to achieve such effect. In the referenced literature, most scholars believed that the variable “company size” needs to be included in the control variables because company size affects the innovation performance of companies conducting M&A to some extent. Thus, it needs to be controlled to reduce interference.

Company age (Age): the age of the company since its establishment. The academic community has not reached a consensus on the relationship between enterprise age and innovation performance. Cohen and Levinthal (1990) considered that the company's age is negatively correlated with innovation performance, and that as the company's age increases, the company may become more rigid, which leads to a significant reduction in the efficiency of the company's R&D and innovation. And Yinlong Li (2015) considered that the relationship between the company's age and innovation performance is related to the innovation environment, and is positively related to innovation performance when in a continuum innovation environment, and negatively related to innovation performance when in a disruptive innovation environment.

Profitability (ROA), the return on total assets of a company for the year. DuPont analysis proposes that Profit/Assets equals Profit/Sales times Sales/Assets. According to

the DuPont decomposition of ROA, ROA can comprehensively reflect the operating profit margin and asset turnover and can be easily obtained from the annual reports, so this dissertation uses ROA indicators to measure profitability. Therefore, the stronger the innovation capability of the company, the better the innovation performance.

Operating capacity (Turo), a company's asset turnover rate for the year. Generally speaking, the high efficiency of the enterprise using assets to generate income indicates that the management personnel of the enterprise have a strong ability to operate and manage and use funds.

Solvency (Debt), which is the company's debt ratio for the year. The debt ratio as a financial indicator also has an impact on innovation performance. The occurrence of innovative R&D activities requires objective conditions of a company, such as whether the company can bear the huge financial burden brought by innovative R&D activities. Therefore, the financial status also affects the management's decision on innovative R&D activities. When the debt ratio is too high, the management’s willingness to carry out innovative R&D may decline, thus affecting the innovation performance.

The variable names and definitions of the above indicators are shown in Table 4-1 below.

Table 4-2 Variable Name and Definition

Variable name	Definition
Total number of patent applications (AplSum)	The natural logarithm of the number of patent applications in one year after the M&A plus 1
Number of invention patent applications (AplInv)	The natural logarithm of the number of invention patent applications in one year after the M&A plus 1
Number of utility model patent applications (AplPra)	The natural logarithm of the number of utility model patent applications in one year after the M&A plus 1
Number of design patent applications (AplDes)	The natural logarithm of the number of design patent applications in one year after the M&A plus 1
Total number of patent authorizations (AutSum)	The natural logarithm of the number of patent authorizations in one year after the M&A plus 1
Number of invention patent authorizations (AutInv)	The natural logarithm of the number of invention patent authorizations in one year after the M&A plus 1
Number of utility model patent authorizations (AutPra)	The natural logarithm of the number of utility model patent authorizations in one year after the M&A plus 1
Number of design patent authorizations (AutDes)	The natural logarithm of the number of design patent authorizations in one year after the M&A plus 1
M&A transaction size (Scal)	The natural logarithm of M&A transaction amount
Absorptive capacity (Res)	The number of R&D personnel in the year after the M&A as a proportion of the total employees of the company
Company size (Size)	The natural logarithm of the company's total assets at the end of the year after the M&A
Company age (Age)	The age of the company since its establishment
Profitability (ROA)	Return on total assets for the year after the M&A
Operating capacity (Turo)	Asset turnover rate for the year after the M&A
Solvency (Debt)	Debt ratio for the year after the M&A

Model Setting. This section examines the relationship between corporate innovation performance and M&A transaction size in two dimensions: the number of patent applications and the number of patents authorizations, with the econometric scale set below.

$$Y_{it}=a_0+a_1*Scal_{i,\ t-1}+b*X_{i,\ t-1}+\lambda_t+\varepsilon_{it} \quad (1)$$

where the set of control variables is:

$$X_{it}=r_1*Size_{it}+r_2*Age_{it}+r_3*ROA_{it}+r_4*Turo_{it}+r_5*Debt_{it} \quad (2)$$

where the subscripts i and t represent the company and the year, λt represents year-specific effect, ε_{it} is a random perturbation term following normal distribution N(0, δ^2). Y represents the total number of patent applications (AplSum), the number of invention patent applications (AplInv), the number of utility model patent applications (AplPra), the number of design patent applications (AplDes), the total number of company patent authorizations (AutSum), the number of invention patent authorizations (AutInv), the number of utility model patent authorizations (AutPra), and the number of design patent authorizations (AutDes). Scale represents the natural logarithm of M&A transaction size, and X is the set of control variables. The control variables selected in this dissertation are company size (Size), company age (Age), profitability (ROA), operating capacity (Turo), and solvency (Debt).

The benchmark model (1) was used to test the impact of M&A transaction size on corporate innovation performance. On this basis, the interaction term of the company's absorptive capacity and its explanatory variable M&A transaction size was introduced to test the moderating effect of absorptive capacity. Then the following econometric model (3) was obtained:

$$Y_{it}=a_0+a_1*Scal_{i,\ t-1}+ a_2*Res_{i,\ t-1}+ a_3*Scal_{i,\ t-1*} Res_{i,\ t-1}+b*X_{i,\ t-1}+\lambda_t+\varepsilon_{it} \quad (3)$$

where the set of control variables is:

$$X_{it}=r_1*Size_{it}+r_2*Age_{it}+r_3*ROA_{it}+r_4*Turo_{it}+r_5*Debt_{it} \quad (4)$$

where the subscripts i and t represent the company and the year, λt represents year-specific effect, ε_{it} is a random perturbation term following normal distribution N (0, δ^2); Res represents the absorptive capacity of the company, which is measured by the proportion of the number of R&D personnel in the total employees of the company in the year after the M&A; and the meanings of other symbols have been explained in the previous section.

Descriptive Statistics and Correlation Analysis

Descriptive Statistics. In this dissertation, descriptive statistics were analyzed for the variables involved, and the results are shown in Table 4-2. Among the response variables, the maximum value of the total number of patent applications (AplSum) is 6.317, and the minimum value is 0.693; the maximum value of the total number of patent authorizations (AutSum) is 6.286, and the minimum value is 0.000, indicating the innovation capability of different companies in China's healthcare industry varies largely on different levels. Meanwhile, the maximum number of invention patent applications is 4.500 and the minimum is 0.000; the maximum number of utility model patent applications is 6.107 and the minimum is 0.000; the maximum number of design patent applications is 3.784 and the minimum is 0.000; the maximum number of invention patent authorizations is 4.111 and the minimum is 0.000; the maximum number of utility model patent authorizations is 6.107 and the minimum is 0.000; and the maximum number of design patent authorizations is 3.700 and the minimum is 0.000. The two sets of data, i.e., the number of applications and authorizations, show that compared with the innovation capability in invention and design, the companies in China's healthcare industry have largely different utility model innovation capability. The mean value of the

core explanatory variable “M&A transaction size” is 7.380, and the standard deviation is 1.737, indicating that there are certain differences in the transaction size of M&A among different companies. The mean value of the moderating variable “absorptive capacity” (Res) is 11.719, and the standard deviation is 6.608, indicating that there are certain differences in the absorptive capacity among different companies in the industry. Among the control variables, the mean value of company size (Size) is 21.600, and the standard deviation is 0.797, indicating that there is a small difference in the size among different companies in the healthcare industry in China. The mean value of company age (Age) is 17.282, and the standard deviation is 6.073, indicating that there is a big difference in age among different companies. The mean value of profitability (ROA) is 0.011, and the standard deviation is 0.013, indicating that there are large differences in the profitability among different companies in China's healthcare industry. The mean value of operating capacity (Turo) is 0.166 and the standard deviation is 0.103, indicating that the operating capacity of the companies is low and there is a large room for improvement. The mean value of solvency (Debt) is 0.291, and the standard deviation is 0.183, indicating that there is a large room for improvement in the ability of companies to use funds provided by creditors for their business activities.

Table 4-3 Descriptive Statistics of Main Variables

Variable	Sample size	Minimum	Maximum	Mean	Standard deviation
Total number of patent applications (AplSum)	281	0.693	6.317	2.889	1.218
Number of invention patent applications (AplInv)	281	0.000	4.500	2.353	1.097
Number of utility model patent applications (AplPra)	281	0.000	6.107	1.449	1.548
Number of design patent applications (AplDes)	281	0.000	3.784	0.763	1.059
Total number of patent authorizations (AutSum)	281	0.000	6.286	2.224	1.396
Number of invention patent authorizations (AutInv)	281	0.000	4.111	1.092	1.154
Number of utility model patent authorizations (AutPra)	281	0.000	6.107	1.447	1.547
Number of design patent authorizations (AutDes)	281	0.000	3.700	0.711	1.149
M&A transaction size (Scal)	281	0.255	10.546	7.380	1.737
Absorptive capacity (Res)	281	0.310	29.670	11.719	6.608
Company size (Size)	281	19.591	23.436	21.600	0.797
Company age (Age)	281	7.000	36.000	17.282	6.073
Profitability (ROA)	281	-0.009	0.072	0.011	0.013
Operating capacity (Turo)	281	0.001	0.176	0.056	0.041
Solvency (Debt)	281	0.021	0.797	0.291	0.183

Correlation Analysis. In studies where correlation analysis is performed on two variables, the correlation coefficient is usually calculated to determine the degree of correlation between the two variables. The Pearson correlation coefficient matrix between the variables derived from the calculations in this dissertation is shown in the table. It can be seen from Table 4-3 that the correlation coefficients between the variables are all less than 0.6, with the largest value being 0.566, indicating that there is absence of high correlation between the main variables. The t-statistic corresponding to the correlation coefficient between absorptive capacity and M&A transaction size is -1.031. The insignificance of the correlation coefficient shows that there is no correlation between absorptive capacity and M&A transaction size. The reason is that the strong absorptive capacity indicates that enterprises have higher efficiency in the face of knowledge that needs to be absorbed and transformed. However, higher absorptive capacity does not mean that enterprises have higher willingness to conduct mergers and acquisitions, because mergers and acquisitions and the maintenance of high-quality human capital both need high costs. For enterprises with large M&A scale, whether they will choose to absorb and maintain high-quality human capital depends more on their own asset size, M&A objectives and development plans, so there is no correlation between their absorptive capacity and M&A scale.

Table 4-4 Correlation Coefficient Matrix

	Company size (Size)	M&A transaction size (Scal)	Absorptive capacity (Res)	Operating capacity (Turo)	Company age (Age)	Solvency (Debt)	Profitability (ROA)
Company size (Size)	1						
M&A transaction size (Scal)	0.252 (1.937)	1					
Absorptive capacity (Res)	-0.149 (-0.283)	-0.081 (-1.031)	1				
Operating capacity (Turo)	0.566 (1.775)	-0.221 (-0.598)	0.130 (0.932)	1			
Company age (Age)	0.335 (1.389)	0.216 (-0.492)	-0.126 (-0.137)	-0.207 (-0.142)	1		
Solvency (Debt)	0.205 (0.123)	0.079 (0.157)	-0.112 (-0.038)	-0.085 (-0.066)	0.026 (0.032)	1	
Profitability (ROA)	-0.090 (-0.092)	0.039 (0.188)	0.034* (0.202)	0.401 (0.137)	0.138 (0.029)	-0.174 (-0.022)	1

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Empirical Tests and Results Analysis of the Number of Patent Applications

Total Number of Patent Applications and M&A Transaction Size. In this dissertation, we first used the model described above to test the effect of the M&A transaction size on the total number of patent applications (AplSum), and the regression results are shown in Table 4-4.

Table 4-5 Benchmark Model Regression Results

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	0.088*	0.085*	0.094*	0.064*
	(2.241)	(2.133)	(2.249)	(2.396)
Size		-0.325	-0.257	-0.438
		(-0.971)	(-1.281)	(-1.324)
Age		0.024	0.022	0.023
		(0.345)	(0.787)	(1.187)
ROA		19.631*	16.766*	20.752*
		(2.295)	(2.117)	(2.495)
Turo		-14.116**	-5.964	-16.088**
		(-3.024)	(-1.649)	(-3.514)
Debt		-0.261	-0.179	-0.417
		(-0.438)	(-0.332)	(-0.715)
_cons	2.128**	9.514	-16.093**	12.663
	(6.062)	(1.446)	(-4.087)	(1.731)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.025	0.228	0.214	0.247

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. A comparison of model (1) and model (2) shows that the coefficient values of M&A transaction size are significantly positive at the level of 10%, indicating that the transaction size of M&A in

China has a significant driving effect on the total number of patent applications of companies in China's healthcare industry, and the larger the transaction size of M&A is, the more likely it is to lead to an increase in the total number of patent applications of companies. In addition, M&A transactions in the healthcare industry are also affected by policy fluctuations and changes in the business environment in different years. Therefore, in model (3), a time-fixed effect was further added. The results show that compared with model (2), the coefficient of the effect of the transaction size of M&A in China on the total number of patent applications of companies in the healthcare industry increased, and it is still significant at the 10% level. At the same time, considering the differences in the operating conditions of different individuals, individual factors were further controlled and we found that the coefficient of the effect of the M&A transaction size in China on the total number of patent applications of companies in the healthcare industry decreases, but the level of significance increased, indicating that there is still a significant positive effect of transaction size on the total number of patent applications.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). The variable “profitability” is significantly positive, indicating that companies with stronger profitability are more likely to achieve an increase in the total number of patent applications, possibly because such companies are more sensitive to advanced technologies and cutting-edge knowledge, and their ability to conduct technological R&D innovation and patent application is stronger. The asset turnover rate reflects the asset utilization efficiency or sales ability of companies. The operating capacity is significantly negative, indicating that companies with higher asset utilization efficiency are more likely to underestimate innovation activities, possibly

because companies with higher asset turnover rate have a stronger ability to generate income from capital, and lack of willingness to invest capital in technology R&D and innovation upgrading activities. The coefficient of company age is positive, that of debt ratio is negative, and that of company size is negative, but the coefficients of the above variables are not significant.

Number of Invention Patent Applications and M&A Transaction Size. It can be seen from the quantitative analysis of the total number of patent applications and the M&A transaction size of companies that for the M&A transactions of companies in China's healthcare industry, the larger the M&A transaction size, the higher the total number of patent applications reflecting the speed of corporate innovation. The relationship between the number of invention patent applications and the transaction size of M&A was analyzed, and the following regression results were obtained.

Table 4-6 Number of Invention Patent Applications and M&A Transaction Size of Companies

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	0.047	0.023	-0.102	0.034
	(1.170)	(0.529)	(-1.729)	(0.753)
Size		0.545**	0.853**	0.490*
		(2.939)	(5.330)	(2.323)
Age		-0.043	-0.036*	-0.042*
		(-1.838)	(-2.121)	(-2.528)
ROA		5.687	5.089	10.757
		(0.686)	(0.607)	(1.154)
Turo		2.070	1.534	-9.775
		(0.589)	(0.492)	(-1.905)
Debt		0.042	0.125	-0.446
		(0.076)	(0.232)	(-0.683)
_cons	1.875**	-9.149*	-14.873**	13.252
	(5.407)	(-2.297)	(-4.289)	(1.616)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.005	0.204	0.262	0.350

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. The results of model (1) to model (4) all show that the coefficient values of the M&A transaction size of companies are not significant, which indicates that the M&A transaction size of companies in China's healthcare industry has no significant improvement effect on the innovation capability of companies in terms of invention patents. A possible reason is that on the one hand, although the acquirers can acquire valuable new knowledge through M&A and generate new innovations by combining new knowledge with its existing

knowledge reserves (Man & Duysters, 2005; Gerpott, 1995), this process often requires companies to redeploy or even increase resource investment to realize the absorption, digestion and re-creation of knowledge. Invention patents, as the type of patents that can best represent the level of innovation of companies, impose higher requirements on companies' knowledge internalization ability. Thus, M&A activities cannot have a significant positive impact on the number of invention patents in the short term. On the other hand, Chinese companies generally have low technological capability and insufficient absorptive capacity. Therefore, when the technological gap is too large, the companies are unable to absorb and transform the acquired information and technologies in a timely manner, thus reducing the R&D spillover effect of M&A. All the above factors have led to the negligible impact of M&A on companies' invention patent applications.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). The variable “company size” is significantly positive, indicating that larger companies are more likely to achieve an increase in the number of invention patents. A possible reason is that on the one hand, larger companies are more likely to realize the allocation of R&D innovation costs through economies of scale; on the other hand, larger companies are more inclined to acquire external knowledge to enhance their comprehensive competitiveness and international status. With the intensification of domestic market competition and the saturation of market share, large companies are more likely to increase their market share through technological innovation. The impact of the company age on the number of patent applications is significantly negative, indicating that the older a company is, the more likely it will

reduce the number of invention patents. A possible reason is that according to the business life cycle theory, the development of a company will go through four stages: development, growth, maturity and decline, and its responses to technological innovation and external knowledge vary at each stage, which will have a certain impact on the application of invention patents. Specifically, young companies with sound operating performance, sufficient working capital and high-quality human resources adopt more liberal and flexible internal management system, and are more willing to expand the market through R&D innovation, while old companies often lose their pioneering and enterprising spirit they had in the early days of its establishment and thus have little willingness to carry out innovative R&D.

Number of Utility Model Patent Applications and M&A Transaction Size. It can be seen from the quantitative analysis of the total number of patent applications and the M&A transaction size of companies that for Chinese companies, the larger the M&A transaction size, the higher the total number of patent applications. The relationship between the number of utility model patent applications and the transaction size of M&A was analyzed, and the following regression results were obtained.

Table 4-7 Number of Utility Model Patent Applications and M&A Transaction Size of Companies

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	0.138**	0.126*	0.120*	0.113*
	(2.650)	(2.426)	(2.303)	(2.090)
Size		0.591*	0.853**	0.476*
		(2.351)	(5.330)	(2.069)
Age		-0.068	0.022	-0.000
		(-0.753)	(0.351)	(-0.001)
ROA		17.990	21.195	18.346
		(1.608)	(1.928)	(1.639)
Turo		-6.979	-6.865	-8.127
		(-1.143)	(-1.639)	(-1.319)
Debt		-0.894	-0.710	-0.919
		(-1.145)	(-0.919)	(-1.170)
_cons	0.335	-10.619	-19.494**	-9.144
	(0.731)	(-1.234)	(-3.792)	(-0.929)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.002	0.157	0.140	0.198

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. A comparison of model (1) and model (2) shows that the coefficient values and significance of M&A transaction size decreased, but are still significantly positive at the 10% level, indicating that M&A transaction size has a significant driving effect on the number of utility model patent applications of companies, and that a larger M&A transaction size is more likely to promote the growth of the number of utility model patents. Considering that the impact of M&A transaction size on innovation is also affected by policy fluctuations in different years, a time-fixed effect was further added in model (3). The results show that compared

with model (2), the coefficient of the impact of the transaction size of M&A on the number of utility model patent applications of companies decreased, but it is still significant at the 10% level. At the same time, considering the differences in the innovation capability of different companies, firm factors were further controlled and we found that there is still a significant positive effect of M&A transaction size on the number of utility model applications at the 10% level. The results of model (1) to model (4) all show that the M&A transaction size of companies in China's healthcare industry has a significant role in promoting the innovation capability of companies in applying for utility model patents. A possible reason is that on the one hand, the higher transaction size of M&A enables the acquirers to easily obtain the production factors and invisible assets of the target companies. At the same time, M&A will also lead to the diffusion of tacit knowledge and the patenting and more effective use of technologies, which will promote the improvement of the R&D efficiency and in turn enhance the R&D and innovation capabilities of the acquirers; on the other hand, since M&A is often accompanied by the redistribution of production factors from the inefficient party to the efficient party, it will promote a more rational allocation of R&D factors and improve the innovation capability of the acquirers. For the above reasons, it can be seen that the utility model patent application imposes lower requirements on the technology digestion and absorptive capacity of the acquirers, helping them to achieve an increase in the number of patent applications in a relatively short period of time.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). The variable "company size" is significantly positive, indicating that larger companies are more likely to achieve an increase in the

number of utility model patents. A possible reason is that on the one hand, large companies can reduce the unit costs of production and technology acquisition by virtue of their advantage in scale, and the marginal benefits of advanced technologies to companies are relatively high. Therefore, large companies are often more sensitive to new technologies and knowledge; on the other hand, compared with SMEs and start-ups, large companies are more likely to enjoy preferential policies and treatment. As a result, the larger the company size is, the greater ability and willingness they have to increase the number of utility model patents.

Number of Design Patent Applications and M&A Transaction Size. The relationship between the number of design patent applications and the transaction size of M&A was analyzed, and the following regression results were obtained.

Table 4-8 Number of Utility Model Patent Applications and M&A Transaction Size of Companies

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	-0.029	-0.048	-0.075	-0.078
	(-0.716)	(-1.141)	(-1.244)	(-1.697)
Size		0.083	0.586**	0.166*
		(0.425)	(3.578)	(2.439)
Age		0.016	0.025	0.017
		(0.643)	(1.481)	(0.978)
ROA		11.684	12.715	11.083
		(1.406)	(1.483)	(1.167)
Turo		-2.893	0.098	-7.998
		(-0.796)	(0.031)	(-1.530)
Debt		0.625	-0.086	0.731
		(1.117)	(-0.156)	(1.098)
_cons	0.979**	-1.121	-11.886**	5.037
	(2.851)	(-0.268)	(-3.351)	(0.603)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.009	0.099	0.127	0.124

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. The results of model (1) to model (4) all show that the M&A transaction size of companies in China's healthcare industry does not have a significant effect on the innovation capability of companies in applying design patents, probably because technologies and products are always in rapid iteration in the healthcare industry. Technological resources are the driving force and source of sustainable development, while due to the low inventiveness, design patents have very limited effect on the improvement of the innovation capability of companies in the health care industry. Thus, large-scale M&A transactions will not have a significant positive impact on the number of design patents of companies.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). The variable "company size" is significantly positive, indicating that larger companies are more likely to achieve an increase in the number of design patents. A possible reason is that there is a certain gap between large companies and SMEs and start-ups in terms of external resource acquisition, financing and management. Large enterprises, relying on their advantage in economies of scale, have an edge over SMEs in cost allocation and cultivation of design capability. Therefore, the larger the company size is, the more likely it is to achieve better results in the number of design patents.

Empirical Tests and Results Analysis of the Number of Patent Authorizations

Total Number of Patent Authorizations and M&A Transaction Size. The speed of post-M&A innovation capability improvement reflected by the total number of patent applications, while the total number of patent authorizations can better reflect the quality of post-M&A innovation capability improvement. Therefore, it is necessary to further investigate the relationship between the M&A transaction size and the number of patent authorizations.

In this dissertation, we first used the model described above to test the effect of the M&A transaction size on the total number of patent authorizations (AutSum), and the regression results are shown in Table 4-9.

Table 4-9 Benchmark Model Regression Results

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	0.123*	0.141**	0.097*	0.120*
	(2.264)	(3.015)	(2.075)	(2.451)
Size		-0.206	-0.049	-0.254
		(-0.524)	(-0.622)	(-0.633)
Age		-0.181*	-0.051	-0.008
		(-2.222)	(-1.426)	(-0.342)
ROA		31.872**	30.224**	33.608**
		(3.168)	(3.162)	(3.331)
Turo		-13.634*	-9.690*	-14.946**
		(-2.484)	(-2.193)	(-2.692)
Debt		-0.498	-0.237	-0.671
		(-0.710)	(-0.362)	(-0.948)
_cons	1.316**	9.320	6.617	7.480
	(3.234)	(1.205)	(1.262)	(0.843)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.026	0.299	0.242	0.260

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. A comparison of model (1) and model (2) shows that the coefficient values and significance of the total number of patent authorizations increased, and the coefficient in model (2) is significant at the level of 5%, indicating that the M&A transaction size has a significant driving effect on the total number of patent authorizations of companies. Companies that actively conduct large-scale M&A transactions are more likely to obtain a higher number of patent authorizations. Since the patent authorizations of companies will be affected by policy fluctuations in different years. Therefore, in model (3), a time-fixed effect was further added. The results show that compared with model (2), the coefficient of the impact of the transaction size of M&A on the number of patent authorizations of companies decreased, but it is still significant at the 10% level. At the same time, considering the differences in the operating conditions of different companies, the individual factors of the companies were further controlled and we found that the coefficient of the effect of the M&A transaction size on the number of patent authorizations of companies increased. The results of model (1) to model (4) all show that the M&A transaction size of companies in China's healthcare industry has a significant positive effect on the increase of the total number of patent authorizations of companies. A possible reason is that on the one hand, for market-acquiring M&A, the purpose is to obtain a larger market share. Therefore, in order to provide more products of higher quality, companies will improve their production technologies and restructure processes, thereby enhancing R&D innovation capability; on the other hand, for technology-acquiring M&A, the purpose is

to acquire the proprietary assets, advanced technologies and factor endowments of the target companies, and the development and utilization of complementary assets by the acquirers will inevitably lead to R&D and innovation activities, ultimately improving their R&D capability.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). The variable "profitability" is significantly positive, indicating that the more profitable the company is, the more likely it is to achieve an increase in the number of patent authorizations. A possible reason is that when a company is more profitable, the company will have more capital to invest in technology introduction and knowledge development, which will help the company improve its internal organizational and management efficiency and optimize resource allocation, thus leading to an increase in its innovation capability. At the same time, the variable "operating capacity" is significantly negative, indicating that the higher the total asset turnover rate of a company is, the less the number of patents authorizations it may obtain. A possible reason is that companies need a certain amount of investment when digesting, absorbing, imitating and re-innovating new technologies, new knowledge and external information. The high operating capacity of a company means that the company is efficient in using capital and quick in obtaining profits through assets. Under such circumstances, the short-sighted tendency of the company will drive it to invest funds in production and reduce the investment in R&D innovation, which is not conducive to the improvement of its innovation capability.

Number of Invention Patent Authorizations and M&A Transaction Size. It can be seen from the quantitative analysis of the number of invention patent

authorizations and the M&A transaction size of companies that for Chinese companies, the larger the M&A transaction size, the higher the total number of patent authorizations. The relationship between the number of invention patent authorizations and the transaction size of M&A was analyzed, and the following regression results were obtained.

Table 4-10 Number of Invention Patent Authorizations and M&A Transaction Size of Companies

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	-0.029	0.047	-0.085	0.022
	(-0.716)	(0.918)	(-1.494)	(0.465)
Size		-0.773	0.475**	0.902*
		(-1.792)	(3.103)	(2.272)
Age		-0.256**	-0.009	-0.037
		(-2.860)	(-0.571)	(1.909)
ROA		20.737	11.150	24.484*
		(1.879)	(1.392)	(2.451)
Turo		-8.181	0.138	-11.370*
		(-1.359)	(0.046)	(-2.068)
Debt		-1.660*	-0.429	-1.960**
		(-2.155)	(-0.829)	(-2.797)
_cons	0.979**	22.569**	-8.383*	21.351*
	(2.851)	(2.660)	(-2.530)	(2.430)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.050	0.415	0.399	0.388

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. The results of model (1) to model (4) all show that the coefficient values of the M&A transaction size of companies are not significant, which indicates that the M&A transaction size of

companies in China's healthcare industry has no significant improvement effect on the number of invention patent authorizations of companies. A possible reason is that on the one hand, M&A transactions targeting at technology and R&D capability focus on the acquisition of technology and strategic assets, while the transformation of technologies and knowledge into the company's output requires a certain amount of absorption and transformation efforts, with effects revealed at a later time. Invention patents, as the type of patents that can best represent the level of innovation of companies, impose higher requirements on companies' knowledge internalization ability. Thus, M&A activities cannot have a significant positive impact on the number of invention patents in the short term. On the other hand, compared with utility model and design patents that can be granted after only a preliminary examination, invention patents are subject to a rigorous examination in terms of novelty, inventiveness and usefulness. All the above factors have led to the negligible impact of M&A on companies' invention patent authorizations.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). The variable "company size" is significantly positive, indicating that larger companies are more likely to achieve an increase in the number of invention patents. A possible reason is that on the one hand, the larger the company size is, the higher the R&D intensity will be, and the more invention patents authorizations the company may obtain; on the other hand, the larger the company size is, the more investment opportunities it faces. These investment opportunities will also lead to an increase in R&D investment, which in turn promotes the increase in the number of patent authorizations. The effect of profitability on the number of invention patent authorizations of companies is significantly positive, indicating that the stronger the

profitability of a company is, the more likely it will lead to an increase in the number of invention patent authorizations. A possible reason is that the improvement of a company's innovation capability does not occur without foundation, but can be realized only when companies select, acquire, absorb and learn advanced technologies, knowledge and information, transform them into their own knowledge, and on this basis, complete imitation and transformation. Only companies with high profitability have the funds to carry out the above learning and absorption process to realize the improvement of innovation capability. The effect of the debt ratio on the number of invention patent authorizations of the company is significantly negative, indicating that the higher the company's debt ratio is, the more likely it will lead to a decrease in the number of invention patent authorizations. A possible reason is that the debt ratio reflects the percentage of assets of the company is raised by borrowing. The higher its debt ratio, the weaker its solvency. In the process of independent innovation and new product development, sufficient funds are needed to support R&D. For companies with weak solvency, huge amounts of R&D investment will put great pressure on their operations and normal functioning. The higher the debt ratio is, the weaker its willingness to invest in R&D, and the less the number of invention patents that can be obtained.

Number of Utility Model Patent Authorizations and M&A Transaction Size. The relationship between the number of utility model patent authorizations and the transaction size of M&A was analyzed, and the following regression results were obtained.

Table 4-11 Number of Utility Model Patent Authorizations and M&A Transaction Size of Companies

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	0.139**	0.127*	0.121*	0.115*
	(2.674)	(2.453)	(2.334)	(2.127)
Size		0.579	0.524	0.461
		(1.327)	(1.028)	(1.037)
Age		-0.068	0.020	0.012
		(-0.752)	(0.326)	(0.469)
ROA		17.926	21.066	18.284
		(1.606)	(1.921)	(1.637)
Turo		-7.046	-13.243**	-8.224*
		(-1.157)	(-3.369)	(-2.338)
Debt		-0.871	-0.692	-0.894
		(-1.118)	(-0.897)	(-1.141)
_cons	0.328	-10.378	0.914	-8.836
	(0.717)	(-1.209)	(0.802)	(-0.899)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.028	0.300	0.283	0.291

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. A comparison of model (1) and model (2) shows that the coefficient values and significance of M&A transaction size have decreased, but are still significantly positive at the 10% level, indicating that M&A transaction size has a significant driving effect on the number of utility model patent authorizations of companies, and that a greater transaction size is more likely to promote the growth of the number of utility model patent authorizations. Considering that the impact of M&A transaction size on innovation is also affected by policy fluctuations in different years, a time-fixed effect was further added in model (3).

The results show that compared with model (2), the coefficient of the impact of the transaction size of M&A on the number of utility model patent authorizations of companies decreased, but it is still significant at the 10% level. At the same time, considering the differences in the innovation capability of different companies, individual factors were further controlled and we found that there is still a significant positive effect of M&A transaction size on the number of utility model authorizations at the 10% level. The results of model (1) to model (4) all show that the transaction size of M&A of companies in China's healthcare industry has a significant improvement effect on the number of utility model patent authorizations of companies. A possible reason is that after the M&A, the parent company and subsidiary will reallocate the resources of both parties. While avoiding repetitive development activities, the acquirer will gather outstanding talents to carry out technological R&D, improve the efficiency of technology upgrades, shorten the R&D cycle, and further enhance its ability to obtain new utility model patents. On the other hand, compared with the strict examination system for invention patents, China adopts a rough preliminary examination system for utility model patents, meaning that a patent can be granted if no substantial defects are found after the preliminary examination. For applicants, the preliminary examination system provides fast examination and approval service with low fees, as well as a protection period more suitable for Chinese patents. For the above reasons, it can be seen that the utility model patent application imposes lower requirements on the technology digestion and absorptive capacity of the acquirers, helping them to achieve an increase in the number of patent authorizations in a relatively short period of time.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). A possible reason for is that R&D often means higher capital costs, and the managers of companies with stronger operating capacity may choose to maximize their personal utility, blindly believe in individualism, and pursue profits and expansion by carrying out cross-border M&A at the expense of other investments in R&D and other activities that are conducive to the companies' long-term development. In other words, they may choose a strategy that is not optimal for the development of the companies, and thus the number of the companies' utility model patent authorizations cannot grow effectively.

Number of Design Patent Authorizations and M&A Transaction Size. The relationship between the number of design patent authorizations and the transaction size of M&A was analyzed, and the following regression results were obtained.

Table 4-12 Number of Design Patent Authorizations and M&A Transaction Size of Companies

Explanatory variable	Model (1)	Model (2)	Model (3)	Model (4)
Scal	-0.029	-0.070	-0.075	-0.078
	(-0.716)	(-1.190)	(-1.244)	(-1.697)
Size		0.440**	0.586**	0.166*
		(2.772)	(3.578)	(2.439)
Age		0.017	0.025	0.016
		(0.978)	(1.418)	(0.643)
ROA		12.613	12.715	11.083
		(1.455)	(1.483)	(1.167)
Turo		0.653	0.098	-7.998
		(0.203)	(0.031)	(-1.530)
Debt		0.218	-0.086	0.731
		(0.393)	(-0.156)	(1.098)
_cons	0.979**	-8.766*	-11.886**	5.037
	(2.851)	(-2.576)	(-3.351)	(0.603)
Year fixed	No	No	Yes	Yes
Firm fixed	No	No	No	Yes
Adjusted R^2	0.010	0.029	0.127	0.129

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Control variables were not included in model (1), and company-level control variables were included in model (2). In models (3) to (4), time and firm-fixed effects were gradually controlled to increase the robustness of the test results. The results of model (1) to model (4) all show that the M&A transaction size of companies in China's healthcare industry does not have a significant positive effect on the number of design patent authorizations, probably because designs tend to be works of art in contrast to inventions and utility models, which are essentially technical solutions. And in the healthcare industry, technologies and products are always in rapid iteration. Technological resources, especially related patents for large equipment with high precision, are the driving force for their companies to choose M&A and the source of their further development. Therefore, large-scale M&A deals in the healthcare industry will not have a significant positive effect on the number of design patent authorizations of companies.

Since model (4) controlled for each fixed effect, the following analysis of control variables was mainly based on model (4). The variable "company size" is significantly positive, indicating that larger companies are more likely to achieve an increase in the number of design patents. A possible reason is that as smart manufacturing and personalized demand are developing today, large companies can leverage their advantages in external resources, financing, management, etc., to gain a head start in cultivating design capability. Therefore, the larger the company size is, the more likely it is to achieve better results in the number of design patent authorizations.

CHAPTER V

TEST OF THE MODERATING EFFECT OF ABSORPTIVE CAPACITY

In the previous chapters, the impact of M&A transaction size on the improvement of companies' innovation performance in China's healthcare industry was examined and analyzed from the dimensions of the number of different types of patent applications and authorizations, respectively. Many studies on reverse technology spillover from investment have pointed out that the absorptive capacity possessed by companies is a prerequisite for acquiring knowledge spillover, and only when acquirers have certain digestion and absorptive capacity can they effectively transform the acquired knowledge spillover into their innovation capability. M&A is one of the foreign investment models of companies, and the absorptive capacity of a company is also a key factor that restricts the effect of knowledge spillover. Therefore, it is necessary to incorporate absorptive capacity into the analytical framework of this dissertation to examine the impact of absorptive capacity on the improvement effect of M&A on innovation performance.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Patent Applications

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Total Number of Patent Applications. In this dissertation, we first used the model (3) described in Chapter IV to test the moderating effect of companies' absorptive capacity on the relationship between the M&A transaction size and the total number of patent applications (AplSum), and the regression results are shown in Table 5-1.

Table 5-1 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Total Number of Patent Applications

Variable	Model 1	Model 2	Model 3
Scal	0.064*	0.088*	0.087*
	(2.396)	(2.047)	(2.411)
Res		0.003	0.011
		(0.034)	(0.125)
Size	-0.438	-0.117	-1.312
	(-1.324)	(-0.982)	(-1.285)
Age	0.023	-0.008	-0.010*
	(1.187)	(-1.789)	(-2.448)
ROA	20.752*	21.119*	19.314*
	(2.495)	(2.143)	(2.007)
Turo	-16.088**	-11.734**	-11.885**
	(-3.514)	(-3.987)	(-2.977)
Debt	-0.417	-0.176	-0.199
	(-0.715)	(-1.055)	(-1.352)
Res*Scal			0.104*
			(2.162)
_cons	12.663	-14.244	-14.497
	(1.731)	(-1.773)	(-1.840)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
Adjusted R^2	0.247	0.248	0.288

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable “absorptive capacity” and the product term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable “absorptive capacity” was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable “M&A transaction size” is positive and significant at the 10% level when the interference of the

moderating variables is not considered, indicating that "M&A transaction size" has a significant driving effect on the total number of patent applications of companies. At the same time, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the total number of patent applications of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the total number of patent applications. A possible reason is that for the acquirers in the copying and imitation stage, their technological and knowledge levels are relatively low, while the absorptive capacity has become a key factor for a company to acquire knowledge and technologies. In this stage, the higher the absorptive capacity of the company is, the more opportunities it has to absorb the technologies and knowledge of the acquiree into its own technical knowledge base, and to transform and innovate the technologies acquired through learning and imitation.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Invention Patent Applications. It can be seen from the quantitative analysis of the moderating effect of absorptive capacity on the relationship between the M&A transaction size and the total number of patent applications that for companies in China's healthcare industry, the stronger the absorptive capacity is, the greater positive impact the M&A transaction size has on the total number of patent applications. The moderating effect of absorptive capacity on the relationship between the M&A transaction size and the number of invention patent applications was analyzed, and the following regression results were obtained.

Table 5-2 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Invention Patent Applications

Variable	Model 1	Model 2	Model 3
Scal	0.034	0.177	0.187
	(0.753)	(0.476)	(0.911)
Res		0.098	0.103*
		(1.943)	(2.198)
Size	0.490*	0.536*	0.315**
	(2.323)	(2.197)	(2.761)
Age	-0.042*	-0.032*	-0.071**
	(-2.528)	(-2.982)	(-3.413)
ROA	10.757	7.438	10.245
	(1.154)	(1.228)	(0.928)
Turo	-9.775	-11.721*	-11.121*
	(-1.905)	(-2.109)	(-2.155)
Debt	-0.446	-0.177	-0.198
	(-0.683)	(-0.888)	(-1.256)
Res*Scale			0.067*
			(2.775)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
_cons	13.252	14.625	14.773
	(1.616)	(1.446)	(1.474)
Adjusted R^2	0.350	0.377	0.378

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable “absorptive capacity” and the product term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable “absorptive capacity” was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable “M&A transaction size” is not significant when the interference of the moderating variables is

not considered, indicating that “M&A transaction size” has a significant driving effect on the number of invention patent applications of companies. However, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the number of invention patent applications of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of invention patent applications. A possible reason is that the application for invention patents puts forward higher requirements for a company's absorptive capacity. In this process, the company will pay more attention to the upgrading and integration of technological capabilities, which requires the transformative capacity as mentioned above. When companies have certain transformative capacity, they will have the ability to transform and combine existing technologies and knowledge with immature technologies and knowledge. In this way, the innovation performance of the company represented by the number of invention patent applications can be rapidly improved.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Utility Model Patent Applications. It can be seen from the quantitative analysis of the moderating effect of absorptive capacity on the relationship between the M&A transaction size and the total number of patent applications that for companies in China's healthcare industry, the stronger the absorptive capacity is, the greater positive impact the M&A transaction size has on the total number of patent applications. The moderating effect of absorptive capacity on the relationship between the M&A transaction size and the number of utility model patent applications was analyzed, and the following regression results were obtained.

Table 5-3 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Utility Model Patent Applications

Variable	Model 1	Model 2	Model 3
Scal	0.113*	0.188*	0.165*
	(2.090)	(2.631)	(2.029)
Res		-0.157	-0.151
		(-1.719)	(-1.643)
Size	0.476*	0.377*	0.347*
	(2.069)	(2.362)	(2.686)
Age	-0.000	-0.163	-0.175
	(-0.001)	(-0.027)	(-0.039)
ROA	18.346	11.390	10.001*
	(1.639)	(1.908)	(2.049)
Turo	-8.127	-10.201	-11.291
	(-1.319)	(-1.771)	(-1.478)
Debt	-0.919	-0.671	-0.557
	(-1.170)	(-0.099)	(-0.084)
Res*Scal			0.082*
			(2.887)
_cons	-9.144	-12.595	-11.849
	(-0.929)	(-1.145)	(-1.196)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
Adjusted R^2	0.198	0.211	0.242

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable “absorptive capacity” and the product term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable “absorptive capacity” was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable “M&A transaction size” is positive and significant at the 10% level when the interference of the moderating variables is not considered, indicating that “M&A transaction size” has a significant driving effect on the number of utility model patent applications of companies. At the same time, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the number of utility model patent applications of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of utility model patent applications. A possible reason is that, what companies acquire through M&A is usually explicit knowledge, but what can really promote the technological capability improvement of companies is the tacit knowledge hidden behind the explicit knowledge, and the acquisition of tacit knowledge depends on the absorptive capacity of companies. In other words, companies with high absorptive capacity can digest, absorb and re-innovate advanced technologies of the target companies through M&A, thereby improving their innovation performance.

In the upgrading innovation stage, the main purpose of M&A is to absorb the high-quality human resources, R&D elements, technologies and knowledge of the target company into the acquirer's own product design and integrate them with its own product design or form innovative ideas and designs by absorbing external technologies and knowledge, thus continuously improving its innovation performance.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Design Patent Applications. It can be seen from the quantitative analysis of the moderating effect of absorptive capacity on the relationship between the M&A transaction size and the total number of patent applications that for companies in China's healthcare industry, the stronger the absorptive capacity is, the greater positive impact the M&A transaction size has on the total number of patent applications. The moderating effect of absorptive capacity on the relationship between the M&A transaction size and the number of design patent applications was analyzed, and the following regression results were obtained.

Table 5-4 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Design Patent Applications

Variable	Model 1	Model 2	Model 3
Scal	-0.078	-0.046	-0.088
	(-1.697)	(-1.445)	(-1.095)
Res		-0.140	-0.133
		(-1.511)	(-1.434)
Size	0.166*	0.104*	0.178**
	(2.439)	(2.551)	(2.998)
Age	0.017	-0.015	-0.003
	(0.978)	(-0.997)	(-1.338)
ROA	11.083	10.992	13.029
	(1.167)	(1.031)	(1.220)
Turo	-7.998	-10.291	-9.380*
	(-1.530)	(-1.781)	(-2.117)

Table 5-4 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Design Patent Applications(contine)

Variable	Model 1	Model 2	Model 3
Debt	0.731	-0.029	-0.031
	(1.098)	(-1.283)	(-1.455)
Res*Scal			0.086*
			(2.128)
_cons	5.037	9.019*	9.202*
	(0.603)	(2.642)	(2.689)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
Adjusted R^2	0.124	0.129	0.187

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable “absorptive capacity” and the product term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable “absorptive capacity” was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable “M&A transaction size” is not significant when the interference of the moderating variables is not considered, indicating that “M&A transaction size” has a significant driving effect on the number of design patent applications of companies. However, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the number of design patent applications of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of

design patent applications. A possible reason is that in the upgrading innovation stage, the main purpose of M&A is to absorb the high-quality human resources, R&D elements, technologies and knowledge of the target company into the acquirer's own product design and integrate them with its own product design or form innovative ideas and designs by absorbing external technologies and knowledge, thus continuously improving its innovation performance.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Patent Authorizations

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Total Number of Patent Authorizations. In the previous section, we explored the moderating effect of absorptive capacity on the relationship between M&A transaction size and total number of patent applications. Then we further used the model (3) described in Chapter IV to test the moderating effect of companies' absorptive capacity on the relationship between the M&A transaction size and the total number of patent authorizations, and the regression results are shown in Table 5-5.

Table 5-5 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Total Number of Patent Authorizations

Variable	Model 1	Model 2	Model 3
Scal	0.120*	0.207*	0.169*
	(2.451)	(2.854)	(2.155)
Res		-0.123	-0.115
		(-1.253)	(-1.171)
Size	-0.254	-0.211	-0.107
	(-0.633)	(-0.321)	(-0.011)
Age	-0.008	-0.012	-0.023
	(-0.342)	(-0.795)	(-1.093)
ROA	33.608**	28.085**	21.211**
	(3.331)	(3.765)	(4.345)
Turo	-14.946**	-19.911**	-17.355**
	(-2.692)	(-3.030)	(-3.561)
Debt	-0.671	-0.487	-0.556
	(-0.948)	(-1.211)	(-1.735)
Res*Scal			0.104*
			(2.061)
_cons	7.480	2.121	2.163*
	(0.843)	(1.943)	(2.014)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
Adjusted R^2	0.260	0.251	0.282

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable “absorptive capacity” and the product term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable “absorptive capacity” was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable “M&A transaction size” is positive and significant at the 10% level when the interference of the moderating variables is not considered, indicating that “M&A transaction size” has a

significant driving effect on the total number of patent authorizations of companies. At the same time, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the total number of patent authorizations of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the total number of patent authorizations. A possible reason is that the absorptive capacity of a company for advanced technologies is the guarantee for technological innovation and the source of continuous innovation, and a higher absorptive capacity will promote the development of scientific and technological innovation activities of the company. If the acquirer has strong absorptive capacity, on top of absorbing the transferred knowledge, it will also conduct imitation-based innovation or even independent innovation, which will continuously narrow the gap between them with technology leaders and continuously gain advantages in the number of patent authorizations.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Invention Patent Authorizations. It can be seen from the quantitative analysis of the moderating effect of absorptive capacity on the relationship between the M&A transaction size and the total number of patent authorizations that for companies in China's healthcare industry, the stronger the absorptive capacity is, the greater the positive impact the M&A transaction size has on the total number of patent authorizations. The moderating effect of absorptive capacity on the relationship between the M&A transaction size and the number of invention patent authorizations was analyzed, and the following regression results were obtained.

Table 5-6 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Invention Patent Authorizations

Variable	Model 1	Model 2	Model 3
Scal	0.022	0.038	0.047
	(0.465)	(0.829)	(1.021)
Res		-0.089	-0.071
		(-0.932)	(-0.760)
Size	-0.902*	-0.894	0.011
	(-2.272)	(-1.741)	(1.317)
Age	-0.037	-0.112*	-0.134*
	(1.909)	(2.039)	(2.335)
ROA	24.484*	21.135*	20.133*
	(2.451)	(2.689)	(2.417)
Turo	-11.370*	-10.339*	-13.378
	(-2.068)	(-2.001)	(-1.785)
Debt	-1.960**	-2.457**	-3.017**
	(-2.797)	(-2.989)	(-2.576)
Res*Scal			0.016**
			(3.461)
_cons	21.351*	-1.660	-2.197
	(2.430)	(-0.430)	(-0.582)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
Adjusted R^2	0.388	0.387	0.405

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable “absorptive capacity” and the product term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable “absorptive capacity” was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable “M&A transaction size” is not significant when the interference of the moderating variables is not considered, indicating that “M&A transaction size” has a significant driving effect on the number of invention patent authorizations of companies. However, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the number of invention patent authorizations of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of invention patent authorizations. A possible reason is that the stronger the absorptive capacity of a company is, the more likely it can "learn in practice" during the use of advanced technology and through informal communication and experience sharing to accumulate technologies and knowledge and improve its technological capability. Then the company will have greater ability and more funds to carry out independent innovation and product development process, which is reflected in the increasing number of patents authorized.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Utility Model Patent Authorizations. The moderating effect of absorptive capacity on the relationship between the M&A transaction size and the number of utility model patent authorizations was analyzed, and the following regression results were obtained.

Table 5-7 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Utility Model Patent Authorizations

Variable	Model 1	Model 2	Model 3
Scal	0.115*	0.112*	0.131*
	(2.127)	(2.377)	(2.085)
Res		-0.158	-0.151
		(-1.722)	(-1.646)
Size	0.461	0.537	0.421
	(1.037)	(0.910)	(1.110)
Age	0.012	-0.011	-0.028
	(0.469)	(-0.933)	(-1.365)
ROA	18.284	15.556	16.384*
	(1.637)	(1.791)	(2.018)
Turo	-8.224*	-11.021*	-13.454*
	(-2.338)	(-2.131)	(-2.776)
Debt	-0.894	-0.773	-0.674
	(-1.141)	(-1.226)	(-1.212)
Res*Scal			0.082*
			(2.887)
_cons	-8.836	-15.543**	-15.797**
	(-0.899)	(-3.144)	(-3.187)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
Adjusted R^2	0.291	0.298	0.381

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable “absorptive capacity” and the product

term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable “absorptive capacity” was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable “M&A transaction size” is positive and significant at the 10% level when the interference of the moderating variables is not considered, indicating that “M&A transaction size” has a significant driving effect on the number of utility model patent authorizations of companies. At the same time, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the number of utility model patent authorizations of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of utility model patent authorizations. A possible reason is that companies, as producers, owners and integrators of knowledge (Grant, 1996), create their core competencies from intangible knowledge assets (Itami & Roehl, 1991). In stark contrast to explicit knowledge, which is codifiable and can be easily disseminated and diffused within and among companies, tacit knowledge has a more complicated dissemination and diffusion process. On the one hand, tacit knowledge is often solidified in the internal production and operation activities of companies or organizations, and guides the production and operation processes of companies in the form of practices, organizational culture, atmosphere, etc. On the other hand, since tacit knowledge is difficult to be codified and expressed and is acquired by individuals in a specific form, its generation and dissemination mainly rely on work

experience and word-of-mouth transmission, and learning tacit knowledge will take a lot of time. Therefore, the stronger a company's absorptive capacity is, the more likely it is to internalize the knowledge resources of other companies through M&A to improve its own R&D and innovation capabilities.

Test of the Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Design Patent Authorizations. The moderating effect of absorptive capacity on the relationship between the M&A transaction size and the number of design patent authorizations was analyzed, and the following regression results were obtained.

Table 5-8 Moderating Effect of Absorptive Capacity on the Relationship Between M&A Transaction Size and Number of Design Patent Authorizations

Variable	Model 1	Model 2	Model 3
Scal	-0.078	-0.065	-0.047
	(-1.697)	(-1.438)	(-1.397)
Res		-0.140	-0.133
		(-1.511)	(-1.434)
Size	0.166*	0.182*	0.193*
	(2.439)	(2.558)	(2.451)
Age	0.016	-0.021	-0.093
	(0.643)	(-0.998)	(-1.255)
ROA	11.083	9.369	11.022
	(1.167)	(1.020)	(0.797)
Turo	-7.998	-8.183	-10.091*
	(-1.530)	(-1.892)	(-2.137)
Debt	0.731	-0.214	-0.331
	(1.098)	(-0.093)	(-1.241)
Res*Scal			0.086*
			(2.028)
_cons	5.037	9.019	9.202
	(0.603)	(0.642)	(1.689)
Year fixed	Yes	Yes	Yes
Firm fixed	Yes	Yes	Yes
Adjusted R^2	0.129	0.134	0.222

Note: *, **, and *** indicate significant at the 10%, 5% and 1% significance levels, respectively, and the *t*-statistics are in parentheses.

Since the model (4) in Chapter IV controlled for each fixed effect, the following analysis of moderating variables was mainly based on the model (4) in Chapter IV, i.e., model (1) in this chapter. The moderating variable "absorptive capacity" and the product term of absorptive capacity and M&A transaction size were not included in model (1), the moderating variable "absorptive capacity" was included in model (2), and the product term of absorptive capacity and M&A transaction size was further included in model (3). As can be seen from the above table, the coefficient of the explanatory variable "M&A transaction size" is not significant when the interference of the moderating variables is not considered, indicating that "M&A transaction size" does not have a significant driving effect on the number of design patent authorizations of companies. However, the product term of absorptive capacity and M&A transaction size is significantly positive at the 10% level, indicating that when studying the impact of the M&A transaction size on the number of design patent authorizations of companies, the magnitude of the impact of absorptive capacity varies significantly at different levels. The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of design patent authorizations. A possible reason is that companies can leverage their absorptive capacity to analyze, process, interpret and understand information obtained from external sources. By promoting the integration of existing knowledge with newly acquired and absorbed knowledge, companies can refine, expand and leverage such knowledge to form new R&D and innovation capabilities and achieve growth in the number of design patent authorizations.

CHAPTER VI

CONCLUSIONS, POLICY RECOMMENDATIONS AND PROSPECTS

Since the rapid development of Chinese companies, an increasing number of companies have acquired technologies and information through investment. M&A, as a form of corporate investment, is becoming more popular among companies, and some studies have shown that M&A has become a lever for corporate capability upgrading. So, can M&A really help Chinese companies improve their innovation capabilities? In this dissertation, an attempt is made to systematically and comprehensively examine the relationship between the relationship between M&A transaction size and the improvement of corporate innovation performance under the framework of M&A theory based on the data of listed companies in China's healthcare industry. At the beginning of this chapter, the results of previous research are summarized and concluded, and on this basis, targeted countermeasures and suggestions on how Chinese companies can better leverage M&A to promote the improvement of R&D innovation capabilities are proposed. In the end, the deficiencies in the research and the direction of future research are explained.

Main Conclusions

Focusing on the impact of M&A transaction size on the improvement of innovation performance of Chinese companies, we firstly conducted a systematic review and analysis of the motivation theories of M&A - efficiency theory, agency theory, undervaluation theory, transaction cost theory, market power theory, and absorptive capacity theory. After further analyzing the evolution and motivation of M&A, we established a theoretical analysis framework for the relationship between M&A and corporate innovation performance improvement, and tested the learning effect of M&A

transaction size. Regression analysis was used to complete multi-dimensional and all-round empirical tests of the effect of M&A transaction size on the innovation capability of companies. The regression model was used to examine the important role of corporate absorptive capacity in the improvement of innovation performance through M&A transaction size. Based on the above analysis, the main conclusions of this dissertation are summarized as follows:

On the Impact of M&A Transaction Size on the Number of Patent Applications of Companies. A theoretical framework on the relationship between M&A and the number of patent applications was built first in this research, and then empirical quantitative methods were used to test the effect of the M&A transaction size on the total number of patent applications, the number of invention patent applications, the number of utility model patent applications and the number of design patent applications, respectively.

Through the research, we found that:① The transaction size of M&A in China has a significant driving effect on the total number of patent applications of companies in China's healthcare industry, and the larger the transaction size of M&A is, the more likely it is to lead to an increase in the total number of patent applications of companies. ② Invention patents, as the type of patents that can best represent the level of innovation of companies, impose higher requirements on companies' knowledge internalization ability. Thus, M&A activities cannot have a significant positive impact on the number of invention patents in the short term. ③ M&A transaction size has a significant driving effect on the number of utility model patent applications of companies, and a greater M&A transaction size is more likely to promote the growth of the number of utility

model patents. ④ Technological resources are the driving force and source of sustainable development for companies in the healthcare industry, while due to the low inventiveness, design patents have very limited effect on the improvement of the innovation capability of companies in the health care industry. Thus, large-scale M&A transactions will not have a significant impact on the number of design patents of companies.

On the Impact of M&A Transaction Size on the Number of Patent Authorizations of Companies. The speed of post-M&A innovation capability improvement reflected by the total number of patent applications, while the total number of patent authorizations can better reflect the quality of post-M&A innovation capability improvement. Therefore, empirical quantitative methods were used to test the effect of the M&A transaction size on the total number of patent authorizations, the number of invention patent authorizations, the number of utility model patent authorizations and the number of design patent authorizations, respectively.

Through the research, we found that:① The M&A transaction size has a significant driving effect on the total number of patent authorizations of companies. Companies that actively conduct large-scale M&A transactions are more likely to obtain a higher number of patent authorizations. ② Compared with utility model and design patents that can be granted after only a preliminary examination, invention patents are subject to a rigorous examination in terms of novelty, inventiveness and usefulness. Therefore, the transaction size of M&A of companies in the healthcare industry has no significant impact on the increase of invention patent authorizations of companies. ③ Compared with the strict examination system for invention patents, China adopts a rough

preliminary examination system for utility model patents, meaning that a patent can be granted if no substantial defects are found after the preliminary examination. For applicants, the preliminary examination system provides fast examination and approval service with low fees, as well as a protection period more suitable for Chinese patents. The utility model patent application imposes lower requirements on the technology digestion and absorptive capacity of the acquirers. Thus, M&A transactions can significantly promote the increase of utility model patent authorizations in the short term. ④ The M&A transaction size of companies in the healthcare industry has no significant effect on the increase of design patent authorizations of companies.

On the Relationship Between Absorptive Capacity and Innovation Performance Improvement Through M&A. The effect of R&D and innovation capability improvement of M&A does not occur without foundation, but can be realized only when acquirers select, acquire, absorb and learn advanced technologies, knowledge and information of the target companies, transform them into their own knowledge, and on this basis, complete imitation and transformation. The regression model was used to examine the important role of companies' absorptive capacity in the improvement of innovation performance through M&A transaction size.

Firstly, regarding the impact of absorptive capacity on the number of patent applications after M&A: ① The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the total number of patent applications. ② The stronger the absorptive capacity, the greater the positive effect of the M&A transaction size on the total number of patent applications. When companies have certain transformative capacity, they will have the ability to transform and combine

existing technologies and knowledge with immature technologies and knowledge, so that they can achieve rapid improvement in the innovation performance of companies in terms of invention patent applications. ③ The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of utility model patent applications. ④ The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of design patent applications.

Secondly, the impact of absorptive capacity on the number of patent authorizations after M&A was further investigated: ① The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the total number of patent authorizations. A higher absorptive capacity will enable the company to, on top of absorbing the knowledge transferred from the acquiree, conduct imitation-based innovation or even independent innovation, which will continuously gain advantages in the number of patent authorizations. ② The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of invention patent authorizations. The stronger the absorptive capacity of a company is, the more likely it can "learn in practice" during the use of advanced technology and through informal communication and experience sharing to accumulate technologies and knowledge and improve its technological capability. Then the company will have greater ability and more funds to carry out independent innovation and product development process, and continuously increase its invention patents. ③ The stronger the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of utility model patent authorizations. ④ The stronger

the absorptive capacity of a company, the greater the positive effect of the M&A transaction size on the number of design patent authorizations. At present, there are few researches in the pharmaceutical industry that study whether pharmaceutical companies can master new technologies, management models and markets after M&A to increase their own market value. This research systematically sorts out the relationship between the role of M&A and innovation in the pharmaceutical industry. By reviewing the literature on corporate M&A, the resource-based theory, strategic management theory, corporate innovation theory, M&A efficiency theory, and synergistic effect theory, reference papers suitable for the study of corporate innovation through M&A in Chinese state-owned pharmaceutical companies are compiled. After that, by using the empirical research method, the M&A data of Chinese pharmaceutical companies in the CSMAR database were collated and analyzed, the structural equation model was proposed, the structural equation model was verified, and eventually the M&A innovation model was proposed. The research results of this dissertation have verified and supplemented the resource-based theory, the theory of enterprise innovation and the mechanism of mergers and acquisitions in the pharmaceutical industry for enterprise innovation.

Policy Recommendations

Policy Recommendations for Target Selection. Success in technology M&A starts with selecting the right target company. When selecting a target company, acquirers are faced with two thorny problems: On the one hand, the uncertainty of the target company resources, on the other hand, the asymmetry of information. Generally, the technological capabilities and related know-hows of target companies are tacit, complex, and socially embedded (Coff, 1999). Although these features can bring hard-to-imitate

technological capabilities to acquirers, they also create significant uncertainty and make it more difficult to assess the value.

Another obstacle is asymmetric information. Target companies have strong incentives to publicly disclose information beneficial to them (Puranam et al., 2006) and conceal information relevant but detrimental to them (Zhu & Zhu, 2016). Serious information asymmetry will make it difficult for acquirers to accurately evaluate the technical resources and capabilities of target companies, which will lead to mismatching or even wrong target selection, and damage the M&A performance.

When dealing with such problem of uncertainty and asymmetry of target companies, the target selection ability of the acquirer is very important. Existing research suggests that three approaches have the potential to help improve the selection ability of acquirers, although each of which may have its own limitations.

First, “Dating”. The specific form of realization is, before M&A, the parties to M&A form a strategic alliance (Higgins & Rodriguez, 2006) or form an investment bond such as venture capital (Benson & Ziedonis, 2009). The practice of "Dating" helps reduce information asymmetry. However, the academic circle has not reached a consensus on whether the relationship above can improve the performance of M&A. Higgins & Rodriguez (2006) found in their research on the pharmaceutical industry that the strategic alliance before M&A improved the M&A performance. However, Benson & Ziedonis (2010) found in their research on the IT industry that the minority equity investment relationship before M&A failed to significantly improve the M&A performance. One possible explanation is, the previous relationship may have caused the acquirers to narrow down the search for the target companies, thereby missing out on the optimal targets.

Second, “Delay”. The so-called "Delay" refers to carry out the M&A upon IPO of target companies. Upon IPO, the target company’s share price reflects the consensus of investors and financial analysts, improving the company's transparency and reducing uncertainty about the technology resources of potential target company. Companies dominated by intangible assets generally have strong incentives to launch an IPO before M&A, in order to improve transparency and increase the probability of being acquired by a larger company. Research by Reuer & Shen (2004) confirmed that companies with large amount of intangible resources are more motivated to actively promote public listing before M&A than other types of companies. However, since that the M&A of listed companies only account for a small part of the total M&A activities, there is no definite evidence that the M&A of listed companies can improve M&A performance. There is

some evidence that M&A of non-listed companies in technology industries dominated by intangible assets can produce better M&A performance (Benson & Ziedonis, 2010). A possible explanation for this is, in the process of waiting for IPO of the target companies, the acquirer missed the best target -- the target company is either acquired by another potential acquirer or becoming a more powerful independent business -- from this point of view, the "Delay" strategy may also be a costly strategy leading to "missing".

Third, signal transmission. Some studies have shown that the acquirers can reduce the information asymmetry of the parties to M&A through credible signals. The support of investment banks, VC, alliance partners and social relations with good reputation to potential target companies can convey the quality signal of potential target companies to the outside world (Reuer & Ragozzino, 2012; Rogan & Sorenson, 2014), and the acquirer may judge the quality of potential targets based on these signals. In addition to potential target signal transmission, Jenner et al. (2017) studied the signal transmission of acquirers and found that acquirers supported by private placement achieved better performance after M&A. Certainly, there is a “dark side” to these channels of information. For example, social relations may limit the search scope of the acquirers focusing only on the target company they are familiar with and, as a result, missing potential targets with greater synergy but in lack of direct relationship (Rogan & Sorenson, 2014).

Policy Recommendations for Capacities. In the early stage of reform and opening up, the introduction of foreign advanced technologies had been an important way for China to catch up with other countries in socio-economic and technological innovation. However, with the rapid development of China's economy and society, the excessive reliance on foreign technologies has substituted local innovation, and due to

incapability of conducting independent innovation, many companies are still in the primary stage of development, totally depending on technology introduction, and cannot realize the transition from "introduction" to "absorption-reinnovation". Therefore, only when capacities of the acquiring companies, i.e., the absorptive capacities, are improved, can the introduction of technologies promote the innovation; or otherwise, independent innovation will result in "innovation substitution" rather than "innovation complementation" effect, which will not only make it impossible to transform it into their own innovation capabilities, but also limit the improvement of independent innovation capabilities.

(1) Integration capacity. M&A integration is a process of resource reallocation of parties to M&A, which is the key to the success of M&A (Haspeslagh & Jemison, 1991). The purpose of technology M&A is not only to obtain the short-term star technology of the other party, but also to obtain the know-how conducive to enhancing the long-term value of the acquirers. However, 80% of M&A cases failed to achieve this purpose, the main reason for which is, the acquirers cannot effectively integrate with the target companies to release the synergistic potential between them (Dunbar, 2014).

The challenge for acquirers is how to balance the integration and autonomy (Haspeslagh & Jemison, 1991; Zaheer et al., 2013). Puranam & Srikanth's (2007) study of M&A in the pharmaceutical and IT industries showed that there was a trade-off between integration and autonomy. On the one hand, technology M&A aims to acquire the technology and related knowledge of the target companies, but the tacit, complex and social embedded natures of technological knowledge resources determine that they are difficult to transfer, and a higher degree of integration is often required to achieve potential synergy (Puranam et al., 2006). On the other hand, the acquired high-tech enterprises tend to maintain their independence and autonomy (Graebner & Eisenhardt, 2004). Excessive integration will lead to the dismission of core employees or the decline of innovation efficiency, thus damaging the knowledge resources and innovation capabilities of the target companies. Kapoor & Lim (2007) found in their research on semiconductor industry M&A that, compared with employees of companies with higher autonomy after M&A, employees of companies with higher degree of integration after M&A applied for fewer patents. Zaheer et al. (2013) found in their research that integration and autonomy are not two ends of a straight line. Where complementarity is the source of synergistic effect, integration and autonomy can be at a high level at the same time -- which conclusion indicates, the degree of integration after M&A should depend on the specific situation.

How to balance the integration and autonomy in technology M&A? The existing literature provides two strategies: "Delay strategy" and "hybrid integration strategy". "Delay strategy" means to carry out integration only after the M&A parties have cultivated an atmosphere of mutual learning and trust (Haspeslagh &Jemison, 1991).

Since that one of the purposes of technology M&A is to overcome the "time compression dis-economy", the time cost of waiting may be very high for enterprises in the high-tech industry. Therefore, the "delay" strategy may be suitable for other types of M&A activities, but less suitable for technology M&A activities. The "hybrid integration strategy" means, some functions or business lines are rapidly integrated while others remain independent. Schweizer (2005) found in his research on M&A in the pharmaceutical industry that if an acquirer quickly integrated non-R&D business and kept R&D department independent, its M&A integration would have better performance.

(2) Absorptive capacity. The acquirers can improve the performance of technology M&A through experience learning and absorption, which includes three aspects: Experience in M&A, internal R&D investment, and corporate venture capital investment activities.

The company's past M&A experience is an important source of corporate learning and absorption (Haleblian & Finkelstein, 1999). Puranam & Srikanth (2007) found in their research that technological acquirers with M&A experience are more able to handle the tension of integration and autonomy. Those with M&A experience will better integrate targets without negatively impacting the future innovation.

Continuous R&D investment within the company is also an important source of learning experience. Internal R&D investment is an important way for enterprises to accumulate absorptive capacity, and the enhancement of absorptive capacity will improve the ability of acquirers to identify attractive targets, price accurately and integrate effectively (Benson & Ziedonis, 2009). If the improvement of technical resources and capabilities of acquirers can create more potential synergy opportunities and greater

possibility of strategic success, it can also increase the attractiveness for ideal target companies (Rhodes-Kropf & Robinson, 2008).

Another kind of relevant experience is learned from the company's venture capital investment activities, i.e., minority investments in other private companies by the acquirers. Corporate venture capital investment activities help to enhance the acquirers' understanding of emerging technologies and new ventures, and can help the acquirers improve the ability to select and evaluate subsequent target companies. The research of Benson & Ziedonis (2009) found that continuous corporate venture capital investment activities could improve the subsequent M&A performance of the acquirers. However, the research of Benson & Ziedonis (2010) found that, compared with the acquisition of other types of start-ups, overconfidence or agency problems at the level of investment projects would increase the failure probability of the M&A of target companies within the portfolio of acquirers.

Innovative talents are the power source for acquirers to improve the performance of technology acquisition by improving the absorption capacity. When implementing M&A to improve technological capabilities, companies should first attach importance to the role of talents in technological transformation and product innovation, and encourage and support creative talents by offering attractive compensation and allowing them to participate in corporate management and strategy formulation, or in other ways. Secondly, due to the lack of experience in the operations of the target companies, the acquirers, on the one hand, may send competent employees and managers to the target companies first to learn and accumulate relevant knowledge and experience, and on the other hand, introduce excellent talents and teams directly. Thirdly, timely training and guidance

should be provided for employees to broaden the vision of employees and introduce the latest research results in the field.

(3) Leadership. In the whole M&A process, senior leadership play a key role (Finkelstein et al., 2009). Senior leadership consists of the CEO, the top management team (TMT), the Board of Directors, and strategic investors. They mostly prefer costly and risky technological M&A. Although CEO plays an important role in strategic decision making, M&A decisions are often made by joint voting after full consultation by senior leadership, due to the complexity and high risk of M&A. Existing literature shows that the decision-making preferences of senior leaders (Steinbach et al., 2017) and heterogeneous experience (Nadolska & Barkema, 2014) have a significant impact on post-M&A performance.

Corporate governance also plays an important role in strategic and complex decisions such as technology M&A. In the corporate governance structure, the Board of Directors plays a particularly prominent role in M&A decision-making, which exerts its influence mainly through two core functions, namely supervision and consultation (Finkelstein et al., 2009). Schmidt (2015) found in his research that when technology M&A activities require more advice and knowledge from the Board of Directors, they are often accompanied by higher M&A performance. According to the research of Kim et al. (2014), the tenure of independent directors will negatively affect the probability, frequency and transaction scale of M&A, but it is significantly positively correlated with M&A performance. The reason for this is, longer tenure enables independent directors to deeply understand the specialized knowledge of technological enterprises and thus provide sound advice to the management.

Therefore, the senior leadership of companies, in the process of formulating an M&A strategy and selecting target companies, should systematically evaluate the company's financing capacity, operating and management experience, internal financial status, and the production and operation activities of target companies, and establish an impeccable pre-merger investigation system to maximize the benefits of the M&A strategy. Experience of success and lessons from failure should also be an important reference for the senior leadership hen conducting M&A. They can gain initiative advantages in the M&A process by summarizing the M&A experience related to specific industries and specific companies.

In addition, the senior leadership of companies should pay attention to the balance between short-term risks and long-term benefits of technological M&A and R&D investment. Senior leadership should attach importance to the management of the internal organization. In the case of technology M&A and R&D investment, internal communication and information transmission should be strengthened to ensure that enterprises can quickly adapt to changes in a short period of time. At the same time, the application scope of absorption capacity should be grasped, so as to avoid blind technological exploration caused by internal redundant knowledge and resources and improve the utilization rate of knowledge. The relationship between R&D investment and absorptive capacity should be balanced so that absorptive capacity can effectively serve R&D investment and enterprise innovation performance.

Finally, the ultimate purpose of enterprises to improve absorptive capacity and carry out innovative M&A is still the long-term interests of enterprises, therefore, the senior leadership of the enterprises should focus on the long-term interests of the

enterprise, to strengthen the construction of innovation platform, promote the organic connection between innovation chains, industrial chains and market demands, to ensure that the use of investment M&A and R&D performance have long-term value.

Policy Recommendations for Knowledge Matching. The acquisition of technological knowledge is the most significant feature that distinguishes technology M&A from other types of M&As. The size and nature of the technological knowledge acquired by the acquirers from the target companies (Ahuja & Katila, 2001) directly determines the maximum "integration potential" of the parties to M&A.

(1) Matching the nature of technological knowledge. The nature of technological knowledge is divided into knowledge similarity and knowledge complementarity. The integration potential is likely to reach the maximum where the technological knowledge of both parties achieves the appropriate balance between similarity and complementarity (Graebner et al., 2010).

On the one hand, if there is no moderate similarity between the M&A parties, the acquirers may lack sufficient absorptive capacity to transfer, digest, absorb and integrate the relevant technological knowledge resources of the target companies. Higgins & Rodriguez (2006) found in their research on the pharmaceutical industry, when the acquirer lacks the treatment type experience of the target company, the technology M&A will show poor performance. Ahuja & Katila (2001) measured the similarity of technological knowledge between the parties to M&A by the degree of overlap in patents in the past. Their research showed that the influence of knowledge similarity between the parties on the post-M&A treatment effect was nonlinear (inverted U). Moderate technological knowledge overlap can improve the performance of chemical industry

technology M&A; Cloodt et al. (2006) replicated the study of Ahuja & Katila (2001) and extended the sample to the electronics, communication, computer and pharmaceutical industries, and the research conclusions were consistent. Bena & Li (2014) empirically tested the relationship between M&A, technological knowledge overlap and technological innovation performance through quasi-experimental measurement methods, and confirmed that the overlap of technological knowledge can improve the post-M&A treatment effect.

On the other hand, in order to create synergy opportunities, a certain degree of complementarity between the parties to M&A is also necessary. The research of Phene et al. (2012) showed that the uniqueness (complementarity) of the target company's technological knowledge improved the exploratory innovation ability of the acquirers. Valentini (2012) believes that in order to accurately evaluate the effect of technology M&A, the innovation performance should be differentiated in terms of quantity and quality (influence, originality and universality). Previous literature suggests that low knowledge similarity reduces the amount of innovation after M&A, but they may ignore the impact on innovation quality. According to the research of Makri et al. (2010), where the knowledge of parties to M&A has low similarity and high complementarity, the quantity of innovation decreases but the quality of innovation is improved. Sears & Hoetker (2014) also reached a similar conclusion. Since innovation quality is the key to improving enterprise value, enterprises should select target companies from the perspective of technological knowledge complementarity when making M&A decisions (Rhodes-Kropf & Robinson, 2008).

In order to further reveal the impact of the nature of technological knowledge on M&A performance, Makri et al. (2010) divided knowledge into scientific knowledge and technological knowledge, and subdivided knowledge correlation into similarity and complementarity. Their research results showed that the similarity of scientific knowledge and technological knowledge between the parties led to path dependence and reduced the novelty of enterprise innovation. The complementarity of scientific knowledge and technological knowledge improved the quantity, quality and novelty of enterprise innovation after M&A. Drawing on the research ideas of Makri et al. (2010), Sears & Hoetker (2014) divided knowledge overlap into target company knowledge overlap and acquirer knowledge overlap. The so-called target company knowledge overlap refers to the degree to which the acquirer has mastered the target company's knowledge, while the master company knowledge overlap refers to the degree to which the acquirer's knowledge is copied by the target company. These two dimensions are not symmetrical, and the mechanism of their influence on the technological innovation performance after M&A is different. The study showed that although knowledge overlap degree of the target company and the knowledge overlap degree of the acquirer strengthened the relationship between the target company's capability and the company innovation (patent), the influence mechanism had significant differences, that is, the former through the influence of absorptive capacity, and the latter mainly by reducing the interruption of group effect to work.

(2) Matching of technological knowledge scale. The absolute scale and relative scale of the technological knowledge stock of the target company will affect the M&A performance. From the perspective of absolute scale, the larger the stock of technological

knowledge of the target company is, the larger the economies of scale and scope of the enterprise's knowledge stock after M&A are, and the greater the potential of innovation and integration is (Ahuja & Katila, 2001). However, this positive effect is short-term and may hinder the company's technological innovation over time (Cloodt et al., 2006).

The academia has not reached a consistent conclusion about the impact of the relative size of the target company's technological knowledge stock on the performance of technology M&A. If the target company has a larger stock of technological knowledge than the acquirer, M&A may have excessive complexity, which will hinder the technological innovation after M&A (Ahuja & Katila, 2001; Cloodt et al., 2006). If this conclusion is true, it means that acquirers should acquire the target company with a relatively smaller stock of technological knowledge. According to the research of Rhodes-Kropf & Robinson (2008), only the "association between strong enterprises" can improve the technological innovation performance after M&A. According to the research of Sevilir & Tian (2012), compared with the acquirer, the larger the knowledge stock of the target company is, the better the innovation performance after M&A will be.

Therefore, the acquirer should strengthen the short-term risk and long-term profit assessment of R&D investment according to the current technological level, grasp the dimension, depth and width of the enterprise's technological knowledge matching, and cause it to match with the existing technological capabilities of enterprise.

Policy Recommendations for Unique System. Compared with western enterprises, the unique institutional environment affects the relationship between technology M&A and innovation performance of Chinese enterprises. Scholars have found that the political advantage or the nature of state-owned enterprises are more important moderating variables. However, for the function of this special system, the theoretical circle has not reached a unanimous conclusion.

Chen & Young (2010), based on 39 overseas M&A cases of listed companies in China from 2000 to 2008, found that investors held a negative attitude towards overseas M&A of enterprises with political advantages (state-owned enterprises), but gave positive attitude to overseas M&A of private enterprises. Ren Shuming et al. (2017), based on the data of listed manufacturing companies on the main board of Shanghai and Shenzhen from 2004 to 2012, found that compared with state-owned enterprises, the possibility of industry M&A had a stronger positive effect on R&D intensity in non-state-owned enterprises. However, some scholars have come to the opposite conclusion. Chi et al. (2011), based on 1148 M&A cases of listed companies in China from 1998 to 2003, found that state-owned equity and corporate governance quality significantly improved the M&A performance of enterprises, while legal equity and prior profitability inhibited the M&A performance. This conclusion suggests, for M&A of Chinese enterprises, investors are more concerned about the political advantages of the acquirer than its economic strength.

From the comparison of sample time interval of the research above, it can be seen that in the early stage of China's economic system transformation, political advantage or state-owned nature can provide a lot of resources for domestic M&A of enterprises.

However, with the deepening of the economic system transition in China, the market will play a decisive role in the allocation of resources, and the role of enterprise political advantages will gradually weaken.

Through various policies, the Chinese government encourages enterprises to improve their technological innovation ability and enhance their competitiveness in the global market through M&A at home and abroad. Compared with technology M&A in western developed countries, China's institutional environment, such as institutional incentives and institutional constraints, may have a greater impact on Chinese enterprises' technology M&A decisions. On the contrary, micro-level factors such as company characteristics and innovation characteristics may explain a large part of the differences in technology M&A decisions of western companies. Therefore, the influence and mechanism of China's institutional environment on technology M&A is particularly important.

In the context of institutional transformation, institutional resources can often provide enterprises with information intermediary, policy dynamics, financial resources, cutting-edge technology and legitimacy. These high-quality resources usually affect the selection of target companies, process integration, and the play of synergies between the M&A parties. Therefore, the author believes that institutional resources can promote the innovation effect of technology M&A through the following ways. Firstly, the state should launch clear policies, increase policy inclination and support for backward regions, encourage cross-region cooperation among government, industry, academia and research communities, establish a mechanism for sharing innovative knowledge, reduce barriers to factor flow, and create a good atmosphere for cooperation. Meanwhile, the state should

eliminate traditional backward industries in time, reduce the dependence of industrial development on natural resources, accelerate industrial restructuring, focus on talent introduction and platform construction, and cultivate a number of leading companies with independent intellectual property rights to achieve coordinated development of companies' innovation capability.

Secondly, the improvement of such institutional and cultural factors as market perfection, validity of the rule of law, and cultural similarity can create a favorable environment for the absorption of foreign advanced technologies, while the lack of these factors may limit the absorption of foreign innovation spillovers. For example, it may block the absorption and application of foreign technologies and may not be conducive to stimulating further innovative output, if a region is rife with corruption and innovation is not effectively protected. Some studies have shown that anti-corruption can significantly improve incentives for innovation by increasing the relative cost of political connections. Therefore, to improve the performance of M&A, efforts should be made to improve the system quality and other soft environment elements.

At the same time, the government and relevant parties should establish and improve the incentive mechanism and linkage mechanism to realize the transformation from foreign innovation to local innovation. ① Incentive mechanism. Including incentives for original innovation and imitation innovation, and incentives for digestion and absorption. The current social atmosphere of national innovation has constituted a good system incentive for innovation activities. However, compared with the innovation incentive, the digestion and absorption incentive is obviously insufficient, which will inhibit the output of imitation innovation and limit the innovation growth. ② Linkage

mechanism. From the perspective of the cognitive development process of technology, it is necessary to promote the linkage between technology introduction and digestion and absorption, and between digestion and absorption and technological innovation, and accelerate the localization of foreign innovation through the normal linkage mechanism. From the perspective of the organization of technological activities, it is necessary to promote the organic integration of technological activities among enterprises, universities, scientific research institutions and the government, so as to form a benign ecological chain of technological introduction, digestion and innovation.

In addition, the importance of institutional resources usually depends on the local institutional environment (Cai Qingfeng et al., 2017; Wei Jiang et al., 2013). With the continuous development of institutions, the role of institutional resources may gradually fade away. Therefore, the mechanism of institutional resources also has certain boundary conditions. However, different regions in China have unbalanced economic development level, and the institutional environment is significantly different among different provinces (Fang et al., 2017). Therefore, the improvement of enterprise innovation ability should also account for the influence of unbalanced characteristics of regions and enterprises on enterprise innovation development. The innovative growth and development of enterprises have obvious unbalanced characteristics, so differentiated innovative development policies should be implemented. The formulation of innovation development policies should pay full attention to this imbalance, adapt measures to local conditions, and promote the flow of high-quality innovation achievements in domestic market through tax incentives, financial subsidies and other ways, so as to maximize the use of innovation spillovers.

Finally, the technology M&A of enterprises with different property rights needs different policy suggestions. State-owned enterprises are a typical feature of the unique system in China. State-owned enterprises play a dominant role in the national economy and strategic industries. Meanwhile, the non-public-owned enterprises of China are also developing vigorously, and the economic and social status improves day by day. However, due to the different nature of property rights, there are obvious differences in their strategies and behaviors. Therefore, the strategic behavior of enterprises of different nature should be fully considered when studying technology M&A. At the Third Plenary Session of the 18th CPC Central Committee, China explicitly proposed to restructure state-owned enterprises through mixed ownership to improve efficiency and competitiveness. On the contrary, technology M&A of non-public enterprises is increasingly driven by market forces to obtain technology resources and enhance innovation ability. However, the imperfect capital market makes small and medium-sized enterprises and non-state-owned enterprises in the Chinese market lack opportunities to increase R&D investment, resulting in low innovation vitality, greater risk and low efficiency of the whole market. Cheng Liwei (2021) also found in the research that for Chinese enterprises, R&D investment has a significant positive role in promoting short-term performance, but negatively affects the performance related to growth. Based on this situation, the government should actively and reasonably promote the development of multi-level capital market, alleviate the financing constraints of non-state-owned enterprises, so that non-state-owned enterprises have sufficient sources of funds for exploratory R&D investment in the period of economic downturn, and have the courage to search for cutting-edge technologies, and can implement R&D investments

in individual technologies, medium and long-term generic technologies, M&A investments in long-term fundamental and disruptive research, or their own R&D.

To sum up, although acquisition of external technology through M&A is of great significance for the improvement of enterprise innovation performance, it is necessary to consider and define the position of technology M&A in the innovation economy for the long-term healthy development of China's economy. Independent innovation, external technology acquisition and other technology acquisition channels complement or replace each other, and their synergistic effect on innovation growth should be fully exploited, instead of reducing R&D by using technology acquisition as a substitute for R&D. Investment in independent innovation is the basic driving force for innovation growth. In recent years, local governments have increased the intensity of R&D investment. However, compared with developed countries, there is still much room for improvement in China's R&D investment. Moreover, we should not only increase the investment in independent research and development, but also give full play to the role of external technologies, and integrate and balance the investment in various technological channels. In the context of innovation-driven environment, it is especially necessary to rethink and define the new position and role of technology introduction in the innovation economy, combine the absorptive capacity of each region, promote secondary innovation, and maximize the complementary effect of technology introduction on innovative growth.

Shortcomings and Prospects

The innovation capability improvement effect of M&A was studied from the perspective of absorptive capacity, and certain research conclusions have been obtained.

However, the following shortcomings exist in this research, and improvement is needed in future work:

There are three shortcomings in the empirical research: 1. Limited by the availability of micro-business data, in the selection of samples, transaction information of M&A in China's healthcare industry was obtained firstly from the CSMAR M&A database. Then, in order to obtain micro information of acquirers, the listed companies were selected as samples, and non-listed companies were removed. In fact, this may produce a selective bias in the samples, because listed companies have better capabilities than non-listed companies, and this fact may lead to less rigorous conclusions; 2. The samples with multiple M&A transaction records were not analyzed separately in the screening of samples, but were added. These companies involved may go on extremely different roads. They may either fall into the infinite loop of "M&A-acquisition of achievements –M&A -acquisition of achievements", or have gained innovation capability from M&A to push them to seek further M&A; 3. The sample statistics show that most acquirers are more likely to carry out M&A again two years after their first M&A. In order to eliminate the impact of previous M&A on the subsequent M&A, deletion was carried out. As a result, for a large number of samples, only the data of the M&A period was retained, so that the dynamic impact and lag effect of M&A on the innovation capability of companies cannot be examined. This is also the limitation to be address in future development of this research.

Secondly, the content of research is insufficient. Regarding the measure of the absorptive capacity of companies, many existing researches have examined the reverse technology spillover of investment from the perspective of absorptive capacity all from

the macro level, without quantifying the absorptive capacity of companies from the micro level. In this research, constrained by the data obtained, shortcomings might exist when using the dimension of human resources to quantify the absorptive capacity of companies, resulting in failure to comprehensively investigate and quantify the absorptive capacity.

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