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DIGITAL M&A AND CORPORATE INNOVATION

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Abstract: The relationship between corporate mergers and acquisitions and innovation has been widely concerned by academia and industry. At present, digital mergers and acquisitions, as an important way for enterprises to achieve digital transformation, are rapidly heating up around the world, and Chinese companies are also investing in digital mergers and acquisitions. However, digital mergers and acquisitions with digital technologies, services and markets as the main acquisition targets are quite different from traditional mergers and acquisitions. Whether digital mergers and acquisitions can effectively improve the innovation performance of acquired companies is still an important question to be answered. On the basis of theoretical analysis, using the digital M&A transaction data and patent data of listed companies in China from 2009 to 2018, we deeply explore the impact of digital M&A on the innovation performance of M&A companies, and compare and analyze (China) domestic digital M&A and cross-border digital M&A. The differential performance of mergers and acquisitions, and at the same time analyze the influence mechanism of the innovation effect of digital mergers and acquisitions from three aspects: knowledge stock, enterprise price-earnings ratio and profit before interest, taxes, depreciation and amortization. In the empirical part, the difference-in-difference method based on propensity score matching is used to construct an econometric model, which can alleviate the self-selection effect and endogenous problems between digital mergers and acquisitions and corporate innovation to a certain extent. The research results show that digital mergers and acquisitions can effectively promote the innovation performance of mergers and acquisitions, and compared with the number of innovations, it has a stronger effect on the quality of innovation; subdividing mergers and acquisitions shows that digital mergers and acquisitions in China can simultaneously promote the number of innovations and innovations of mergers and acquisitions. At the level of theoretical analysis, combining the characteristics of digital economy and technology with traditional M&A theories enriches the research objects and research mechanisms of existing M&A studies. At the level of empirical evidence, the causal identification of the innovation effect of digital mergers and acquisitions will help companies better improve innovation performance through digital mergers and acquisitions, and provide important references for the government to better support and guide companies to participate in digital investment.
Keywords: Digital mergers and acquisitions; Listed companies; Innovation quantity; Innovation quality; Causal identification

1. INTRODUCTION

With the advent of the digital economy era, new opportunities and values are constantly being discovered and created, and enterprises' demand for innovation is also increasing day by day. From a micro perspective, the rapid change and wide application of digital technologies such as big data, cloud computing, artificial intelligence and the Internet of Things have brought different degrees of digital disruption to enterprises in various industries. In this regard, only by actively innovating to achieve digital transformation faster can enterprises maintain their competitive advantages and seize new opportunities. From a macro perspective, according to the estimates of China Academy of Information and Communications Technology, the overall scale of China's digital economy and its contribution to GDP have continued to rise rapidly in recent years, and its nominal growth rate is also higher than that of GDP in the same period, which has become a new driving force for China's economic growth. The digital economy is in the ascendant. Although there are national policies behind it, the increasingly perfect digital infrastructure construction and the support of a large digital consumer group, the innovation drive of enterprises is the key to long-term development. At the same time, digital investment represented by digital mergers and acquisitions, as the backbone of the digital economy, is not only an important way for companies to reposition and participate in competition in the digital age [1], but also an important way for companies to quickly and directly acquire digital technologies and services.

In view of this, this study focuses on the impact of digital mergers and acquisitions on the innovation performance of Chinese listed companies, uses the industry classification of the PitchBook database to identify digital mergers and acquisitions transactions of Chinese listed companies, and takes the completion of digital mergers and acquisitions transactions as a quasi-natural experiment. The difference-in-difference method systematically evaluates the innovation effect and mechanism of digital mergers and acquisitions to reveal the mechanism of digital mergers and acquisitions to promote corporate innovation performance.

It has certain policy implications for the government to effectively support and guide enterprises to participate in digital investment and promote enterprises to carry out innovative activities.

2. REVIEW OF RELEVANT RESEARCH

Regarding the impact of mergers and acquisitions on corporate innovation activities, domestic and foreign scholars have carried out a lot of theoretical and empirical research from multiple perspectives, but the conclusions are not the same.

On the one hand, some studies support the theory of innovation inhibition, and believe that mergers and acquisitions inhibit corporate innovation [2-3]; on the other hand, the theory of innovation incentives has also been supported and verified by some scholars, that is, mergers and acquisitions have a positive effect on corporate innovation [4]. Most studies in the Chinese context support the theory of innovation incentives. In the early research, Ren Shuming et al. [5] investigated A-share manufacturing companies and found that the possibility of mergers and acquisitions in China (hereinafter referred to as domestic) within the industry and the improvement of bargaining power will help increase corporate R&D investment. This study only explores the relationship between mergers and acquisitions and corporate R&D investment from the industry dimension, and does not touch on the subject of corporate mergers and acquisitions. [6] turned their perspective to cross-border mergers and acquisitions, and found that cross-border mergers and acquisitions can improve corporate innovation performance by improving the internal R&D efficiency of listed companies. But its analysis ignores the more general phenomenon of domestic mergers and acquisitions. Coincidentally, Xian Guoming et al. [7] also investigated the effect of cross-border mergers and acquisitions on corporate innovation performance, but found that cross-border mergers and acquisitions mainly increase the number of innovations through external knowledge acquisition rather than internal R&D investment. A horizontal comparison shows that the research contents of Zhang Wenfei et al. [6] and Xian Guoming et al. [7] are generally similar, but they only use cross-border M&A data from different sources to obtain differentiated conclusions. This study aims to reduce the unsoundness of the research conclusions caused by data selection bias with the help of more comprehensive coverage of mergers and acquisitions and patent data. In existing studies, Chen Aizhen et al. [8] comprehensively examined the impact of domestic and cross-border mergers and acquisitions on corporate innovation performance.

When analyzing the impact of mergers and acquisitions on corporate innovation performance, the above studies construct innovation performance indicators based on the number of patents, essentially staying in the quantitative dimension and ignoring the more important inspection of innovation quality. The impact of digital mergers and acquisitions on the quality of corporate innovation. and

At the same time, research focusing on the innovation effect of digital mergers and acquisitions in the context of China It is still quite limited. In the field of digital economy, only Li Chuntao et al. [9] investigated the impact of regional financial technology development on the innovation of new third board enterprises, and found that financial technology mainly improves the number of innovations of enterprises by alleviating corporate financing constraints and increasing tax returns. It can be considered that the above studies have examined the M&A behavior of Chinese companies or the impact of the development of the digital economy on corporate innovation, but none of them have directly investigated the innovation effect of digital M&A, a M&A behavior centered on digital technology.

Some foreign studies discuss the innovation effect of digital mergers and acquisitions. In terms of theoretical analysis, some studies have shown that the inherent dynamics and scalability of digital technologies may promote post-merger knowledge combinations, leading to the establishment of digital knowledge bases and digital innovation [10-11]. However, some studies also believe that from the perspective of technology integration and absorption, if the technical knowledge difference between the two parties in digital mergers and acquisitions is too large, it will increase the difficulty of technology integration and bring challenges to the innovation of the acquiring company [12-13]. In terms of empirical research, HAN-ELT et al.[14] used the digital mergers and patent data of 30 large automakers in the world from 2000 to 2016, and found that digital mergers and acquisitions can help auto companies build digital knowledge bases, thereby promoting corporate Digital innovation and performance improvement. However, its conclusions are based on the investigation of developed countries, and have limited enlightenment for developing countries. On the basis of the above research, this study examines the causal effect of digital mergers and acquisitions on corporate innovation performance in the context of China, and comprehensively incorporates the two dimensions of innovation quantity and innovation quality to compare and analyze the differential innovation effects of digital mergers and acquisitions compared with non-digital mergers and acquisitions , in order to provide a useful supplement to the existing research.

3. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

3.1 The Innovation Effect of Digital Mergers and Acquisitions on Mergers and Acquisitions

Most of the existing research on mergers and acquisitions and corporate innovation does not distinguish the industry of mergers and acquisitions. The digital mergers and acquisitions discussed in this study focus on the digital industry, which is a subset of all mergers and acquisitions. Therefore, when exploring the innovation effect of digital mergers and acquisitions, it is necessary to combine digital The characteristics of the industry are discussed. From a theoretical analysis, most digital mergers and acquisitions are mergers and acquisitions of technologies (or companies) that have market potential but are not yet mature in the digital industry, so they show a strong motivation for technology acquisition, that is, companies hope to acquire digital technologies through digital mergers and acquisitions. and services to build the digital capabilities needed within the enterprise to accelerate digital transformation. However, the technology and knowledge acquired by enterprises from M&A activities are often highly contextualized, and it is difficult to transplant between different scenarios[15]. There is at least a partial overlap to have a positive impact. When the technology and knowledge of the acquiring party and the acquired party are too close, there may be insufficient novelty for the acquiring party, and excessively differentiated knowledge is too challenging for the acquiring party, increasing the difficulty of technology integration [13]. However, digital technology naturally has a wide range of usage

scenarios beyond geographical and industry restrictions, which makes the application and innovation process of digital technology after being acquired different from other technologies [16], which essentially greatly reduces the need for differentiated companies to acquire companies. Difficulty in integrating digital technology knowledge. The self-referential feature of digital technology enables M&A companies to realize digital technology accumulation without all the necessary prerequisites; reprogrammability endows digital technology with a separation of form and function, which simplifies the integration of M&A companies. The technical adjustment made by digital technology reduces the cost of repeated use, and even expands derivative innovation through technical reorganization [17]; data homogeneity means the separation of content and media, which helps mergers and acquisitions to access various data more efficiently and conveniently and Carrying out applications reduces application costs in technology integration. The extensibility (such as reprogrammable), mobility (such as convenient data circulation) and homogeneity (such as standardized software language) embodied in the above-mentioned digital technologies are the core of digital technology [18], endowing digital technology with Affordability, that is, different organizations and individuals can use the same digital technology to achieve various purposes of differentiation [11,19], which in turn provides sufficient opportunities for technology integration for M&A companies to use digital technology [20], making the technology contained in technology knowledge can be better disseminated across enterprise boundaries, and ultimately promote mergers and acquisitions of knowledge reorganization and creation [21], and promote enterprise digital transformation and innovation [14]. Based on the above analysis, this study proposes a hypothesis.

3.2 Differentiated Innovation Effects of Domestic Digital M&A and Cross-Border Digital M&A

Cross-border mergers and acquisitions, this phenomenon may be more common in the digital economy beyond geographical restrictions. In view of the large differences between domestic M&A and cross-border M&A, some scholars discuss and compare the two separately when examining the effects of M&A [22-24]. From a simple comparison, domestic mergers and acquisitions allow companies to grow in the local market and familiar business environment, but they often form strong market power, which easily inhibits the motivation of enterprises to innovate; while cross-border mergers and acquisitions not only cross companies but also cross borders, tend to Acquiring proprietary assets or technologies of host country enterprises, the higher the technology and asset complementarity of both parties to the transaction, the higher the success rate of M&A transactions, and they are more willing to invest in additional R&D after M&A to prevent competitors from catching up[24-25], However, while helping enterprises to open up overseas markets, they will also face higher M&A negotiation and integration costs[26]. However, since the home country and the host country may have differences in many aspects such as resources, capital, culture, and systems, it provides a larger and more diverse resource pool for enterprises to acquire the knowledge they need, especially complementary knowledge, and thus generate stronger resources. The synergistic effect and technology spillover effect will ultimately bring a more positive impact on corporate innovation. According to empirical evidence, cross-border mergers and acquisitions often bring stronger efficiency improvement effects and weaker resource substitution effects than domestic mergers and acquisitions, and generally strengthen the innovation effect of mergers and acquisitions [8]. In addition, in cross-border mergers and acquisitions, due to the long geographical distance between the merger and acquisition parties, a natural market segmentation has been formed, which has largely broken the monopoly effect that may inhibit innovation. Even the global diversified digital market opened by cross-border digital mergers and acquisitions is still It helps to force enterprises to innovate in order to cater to consumers with different cultural and institutional backgrounds. This is even more powerful for digital mergers and acquisitions that can transcend geographical restrictions. Cross-border digital mergers and acquisitions can help companies expand the breadth of their digital knowledge base by promoting companies to absorb and internalize knowledge and technologies from the global diversified digital market. Degree, so as to achieve technological innovation. In fact, in recent years, more and more Chinese companies have "goed out" to deploy overseas markets, and some countries and regions in Europe and the United States have even increased their investment in Chinese companies due to concerns that "the technology transfer of cross-border mergers and acquisitions will enhance the innovation capabilities of Chinese companies." M&A scrutiny. In addition, although China's long-term investment in the field of digital information technology has achieved initial results, such as big data and artificial intelligence and other fields have reached the world's leading level, compared with companies in developed countries led by the United States, Chinese companies are in many There is still a big gap in the R&D and innovation capabilities in the digital field. Therefore, overseas advanced digital technology resources are more complementary to Chinese companies, making the technical knowledge spillover effect of cross-border digital mergers and acquisitions likely to be more significant. Based on the above analysis, this study proposes a hypothesis.

3.3 Influence Mechanism: Knowledge Synergy and Financial Synergy

Resource integration is the most critical link in the whole process of mergers and acquisitions, and it has an important impact on the resource conversion and utilization capabilities of the merged and acquired enterprises[27-28]. Existing studies have found that with the gradual integration of intangible assets such as technical knowledge, management experience, and marketing network, on the one hand, it increases the knowledge stock of acquired companies, helps to improve their productivity and resource allocation efficiency, and produces knowledge synergy [29]; On the other hand, it can also enhance the economies of scale or scope of products, thereby promoting the improvement of profit margins

and generating financial synergy. Of course, digital mergers and acquisitions are no exception. With the integration and application of digital technology and digital management and operation experience, the intellectual capital of mergers and acquisitions will inevitably be greatly improved. At the same time, the nature of digital technology that transcends geographic restrictions and the network effects of the digital age can also allow economies of scale and scope to be easily realized. However, the asset-liability ratio of an M&A company often increases after paying a large amount of transaction money [30]. In the short term, the resource substitution effect weakens the ability and motivation of the company to increase innovation investment and internalize knowledge, and it is difficult to significantly improve the company's profitability. [31]. However, this study believes that such financial negative effects caused by rising debt may not be true in digital mergers and acquisitions, and even the enhancement of digital mergers and acquisitions to corporate financing capabilities and profitability will further strengthen the financial synergy of mergers and acquisitions. First, in terms of deal value, according to Boston Consulting Group, digital mergers and acquisitions are concentrated in start-ups with low valuations, of which 81%

The amount of digital M&A is less than USD 100 million, and only 3% exceeds USD 1 billion [32]; in terms of payment method, the acquisition of a risky digital target company in 100% cash may expose the M&A party to excessively high business requirements. reputation and future amortization, so companies prefer to use earn-out payment plans or other deferred payment mechanisms rather than cash payments [33].

It can be seen that digital mergers and acquisitions with smaller transaction amounts and more flexible payment methods make mergers and acquisitions companies face less debt pressure. Secondly, in recent years, the median enterprise value multiple of acquired companies in digital mergers and acquisitions has risen from 13 times in 2009 to 26 times in 2017, doubling the valuation [1], which shows that the industry has a strong interest in digital technology and the digital market. In a state of fierce snatching. Therefore, when a company becomes a more qualified "digital player" by successfully completing digital M&A, it can gain more flexibility in future transaction financing, thereby promoting the implementation of the next round of digital M&A [33]. In addition, digital mergers and acquisitions are helpful to the digital transformation of enterprises [34], allowing enterprises to have greater profit margins and profitability in the era of fierce competition in the digital economy. It is worth noting that digital M&A does not simply insert a digital business unit for the acquired company through a technology-based M&A, but adopts a programmatic M&A method to carry out multiple small and medium-sized M&As under the framework of the company's digital development strategy. This M&A model, which does not rely on intermittent "big bang" transactions, reflects the flexible use of capital and the diversification of investments, which can often achieve higher excess total shareholder returns in today's rapidly changing business environment [35-36]. Based on the above analysis, this study proposes a hypothesis.

4. RESEARCH DESIGN

4.1 Variable Construction and Data Sources

4.1.1 Interpreted variables

This study mainly examines the changes of enterprise innovation quantity (Pta) and innovation quality (Ptc) before and after digital mergers and acquisitions from the perspective of innovation output. In order to reduce the impact of the patent bubble, the number of innovations is measured by the logarithm of the number of valid patent applications of the enterprise plus 1 in the current year, that is, the logarithm of the number of patents that the enterprise finally obtained in the year, and the types of patents include invention patents and utility model patents. For innovation quality, refer to the practices of HALL et al. The number of citations of other patents not participated in the application by the enterprise is measured by the logarithm of the number of citations of each invention patent applied by an enterprise in a certain year within 3 years after publication and summed up to the enterprise-year level and then added to 1 to take the logarithm. quality. The enterprise patent data comes from the global intellectual property database under BvD, which covers the global patent information of Chinese listed companies.

4.1.2 Explanatory variables

This study mainly analyzes the impact of digital mergers and acquisitions on the innovation performance of Chinese listed companies. Based on existing research [14,39], this study defines digital mergers and acquisitions as mergers and acquisitions conducted by companies to build their own digital capabilities, mainly to acquire digital technologies. and services or to seize the digital market. In order to identify M&A samples that meet the aforementioned definition as much as possible, this study refers to the method of Jiang Dianchun et al. [40], and regards the M&A behavior of enterprises in the digital economy industry as digital M&A. According to the digital economy defined in the "G20 Digital Economy Development and Cooperation Initiative", "production price with digital factors.

According to the nature of "value", this study designates 26 industries in the PitchBook database as digital economy industries, roughly equivalent to the "digital industrialization" sector defined by the China Academy of Information and Communications Technology, excluding the broader "industrial digitalization" sector. Therefore, this study screened out the digital M&A transactions announced from the PitchBook database from January 1, 2009 to December 31, 2018, with Chinese listed companies as buyers. For enterprises, only the first digital mergers and acquisitions are retained; at the same time, in order to avoid the mixed impact of multiple digital mergers and acquisitions, enterprises with repeated digital mergers and acquisitions within 3 years are eliminated; financial industry samples and samples with missing financial indicators are excluded. 2009, 2010, 2017 There is no complete 3-year digital M&A transaction information

corresponding to the digital M&A transactions that occurred in the 4 years of 2018. After completing the above steps, a total of 96 digital M&A transaction samples from 2011 to 2016 were finally obtained, of which 14 companies had conducted overseas digital M&A transactions. Mergers & Acquisitions: Figures for M&A deals are sourced from the PitchBook database.

4.1.3 Matching variables

The empirical results of this study are mainly based on matched samples. Therefore, with reference to STIEBALE et al. (Lfp): the logarithmic value of the ratio of the main business income of the enterprise to the number of employees; ③ capital intensity (Klr): the logarithmic value of the ratio of the total fixed assets of the enterprise to the number of employees; ④ the average wage of the enterprise (Wag): the payable employee The logarithmic value of the ratio of salary to the number of employees; ⑤ Age of the enterprise (Age): the year of the data minus the year of establishment of the enterprise plus 1 and take the logarithmic value; ⑥ Return on assets (Roa): the ratio of the net profit of the enterprise to its total assets; ⑦ R&D intensity (Rdi): The ratio of enterprise R&D expenses to total fixed assets. The above variables are all treated with a lag of one period. In addition, this study also draws on the practice of BRUCAL et al. (Inc) and the 3-year citations of utility model patents (Umc) with a lag of 1 period, and calculated the difference between the lag 1 period and the lag 2 period of these four matching variables in the follow-up test of the balance of enterprise characteristics Ex-ante trends in firm innovation performance. In this study, when using the pre-matching samples for OLS regression, the matching variable ①~variable ⑦ is used as the control variable. The financial data of the company comes from the Compustats database, covering all Chinese listed companies listed on the world's major trading markets, and docking numbers with stock codes M&A transactions and corporate patent data. Considering the influence of extreme data values on the empirical results, all variables are shrinked by 1%.

Combined with the sample screening process in 3.1.2, this study obtained a total of 28,441 sample observations from 3,532 companies from 2009 to 2018. Among the 3,532 companies, 96 had digital mergers and acquisitions, and 3,436 had no digital acquisitions. Mergers and acquisitions, including 2,380 firms with only non-digital mergers and acquisitions and 1,056 firms without any mergers and acquisitions. Only non-digital M&A occurred when non-digital M&A occurred although no digital M&A occurred. Calculate the corresponding ΔPta, ΔIna, ΔUma, ΔPtc, ΔInc, and ΔUmc in 2011 using the sample observations in 2009 and 2010, and use the sample observations in 2017 and 2018 to calculate the companies in the treatment group with the first digital M&A in 2016 Innovation performance in (T + 1) and (T + 2) periods.

4.2 Research Method and Model Setting

This study mainly evaluates the impact of digital mergers and acquisitions on the innovation quantity and quality of Chinese enterprises. Since digital mergers and acquisitions are not random behaviors of enterprises, as an internal decision-making of enterprises, only enterprises with obvious technological advantages or high production efficiency tend to carry out mergers and acquisitions[30], directly using the two-way fixed effect model may lead to biased estimation results. Therefore, this study adopts the difference-in-difference method based on propensity score matching (PSM-DID) to accurately evaluate the causal effect of digital mergers and acquisitions on corporate innovation performance according to the common practice of existing research. This study regards the completion of digital M&A transactions as a quasi-natural experiment, taking 96 companies with digital M&A as the treatment group and 3,436 companies without digital M&A as the control group. Specifically, in the matching process, it is ensured that the innovation performance of the treatment group and the control group in the two periods before the digital M&A are consistent. And group-matched by standard industry norm 2-digit industry - year to control for common trends over industry time.

After the above matching process, 87 companies were successfully matched, accounting for 90.625% of the sample of companies that had digital mergers and acquisitions. Therefore, 87 companies with digital mergers and acquisitions are taken as the treatment group, and 87 companies without digital mergers and acquisitions are taken as the control group. Furthermore, this study establishes an econometric model to investigate the innovation effect of digital M&A, namely

$$Innf,t = \alpha f + \gamma Dt + \beta Dmaf\ Dt + "f,t \quad (1)$$

Among them, f is the enterprise; t is the year, t = T-2, T-1, T, T + 1, T + 2, T is the year when digital mergers and acquisitions occur; Innf , t is the innovation performance of the enterprise, divided into innovation quantity and Innovation quality; Dt is a time dummy variable, the value is 1 in the year of digital mergers and acquisitions and the following years, otherwise it is 0; Dmaf is a grouping dummy variable, the value is 1 in the case of digital mergers and acquisitions, otherwise it is 0; αf is the value of the enterprise Fixed effect, used to control the influence of enterprise characteristic factors that do not change over time on enterprise innovation performance; γ and β are estimated coefficients; "f , t are random interference items. It should be noted that each time only for the top 1 of digital mergers and acquisitions period ((T - 1) period) and a certain period after the digital M&A ((T + s) period, s = 0,1,2) for a total of two periods of regression to compare the period before and after the digital M&A The difference in the innovation performance of two groups of firms between a certain period, as the treatment effect of digital M&A on firm innovation performance [41]. This study focuses on β, which characterizes the causal effect of digital M&A on firm innovation performance, and β > 0 indicates that The innovation performance of enterprises with digital mergers and acquisitions improves more than those without digital mergers and acquisitions.

4.3 Balance Test of Matched Samples

4.3.1 Transaction distribution balance

Figure 2(a) and Figure 2(b) respectively show China's

The distribution of the proportion of all transactions and the number of matching transactions between digital M&A and non-digital M&A of listed companies. The vertical axis is the ratio of the number of M&A transactions in the current year to the total number of M&A transactions from 2011 to 2016. It can be seen that the distribution of the annual number of digital M&A transactions in the sample after matching is relatively close to the distribution of the annual number of digital M&A transactions in all samples, indicating that the matching method in this study has not significantly changed or distorted the year-by-year trend of the number of digital M&A transactions , the matched samples are more representative.

4.3.2 Balance of enterprise characteristics

Table 1 shows the test results of enterprise characteristics balance before and after matching,

All matching variables were lagged 1 period. In Table 1, column (1)~(3) The column gives the comparison results of the mean values of enterprise characteristic variables between digital M&A enterprises before matching and control group enterprises, involving 96 sample observations of the year before the digital M&A of 96 treatment group enterprises and 3436 control group enterprises with a lag of 1 19,957 sample observations that were not missing for period matching variables. If at least passing the t-test at a significance level of 5% is used as the standard, digital M&A companies have significantly larger scale, higher labor productivity, higher capital intensity, older companies, and higher R&D intensity, indicating that digital M&A companies There are obvious differences between enterprises and non-digital M&A enterprises in many enterprise characteristics. In addition, the quantity and quality of innovations and innovations of digital mergers and acquisitions companies are high before the mergers and acquisitions, that is, the innovation performance is better, which may lead to the problem of selection bias. Columns (4) to (6) show the comparison results of the mean difference of enterprise characteristics between the matched processing group and the control group.

Table 1 Balance Test Results for Enterprise Characteristics

	before matching treatment group (1)	before matching control group (2)	difference (3) = (1) - (2)	Match post-processing group (4)	matched control group (5)	difference (6) = (4) - (5)	Match post-processing group (7)	Match pretreatment group (8)	difference (9) = (7) - (8)
match variable									
ina	1.487	1.140	0.347**	1.493	1.384	0.109	1.493	1.487	0.006
Uma	0.948	0.913	0.035	0.902	0.732	0.170	0.902	0.948	- 0.046
Inc.	1.532	1.043	0.489***	1.536	1.449	0.087	1.536	1.532	0.004
Umc	0.733	0.644	0.089	0.687	0.619	0.068	0.687	0.733	- 0.046
size	7.601	7.229	0.372***	7.607	7.438	0.169	7.607	7.601	0.006
Lfp	9.761	9.486	0.275***	9.801	9.631	0.170	9.801	9.761	0.040
Klr	11.296	10.971	0.325***	11.355	11.071	0.284***	11.355	11.296	0.059
Wag	7.318	7.066	0.252*	7.334	7.404	- 0.070	7.334	7.318	0.016
Age	2.778	2.683	0.095***	2.780	2.795	- 0.015	2.780	2.778	0.002
Roa	0.056	0.046	0.010*	0.055	0.053	0.002	0.055	0.056	- 0.001
Rdi	0.061	0.037	0.024**	0.063	0.084	- 0.021	0.063	0.061	0.002
other variables									
Pta	1.776	1.478	0.298*	1.768	1.596	0.172	1.768	1.776	- 0.008
Ptc	1.699	1.281	0.418**	1.693	1.656	0.037	1.693	1.699	- 0.006
ΔPta	0.157	0.075	0.082	0.126	0.131	- 0.005	0.126	0.157	- 0.031
ΔIna	0.150	0.061	0.089	0.115	0.131	- 0.016	0.115	0.150	- 0.035
ΔUma	0.057	0.062	- 0.005	0.043	0.085	- 0.042	0.043	0.057	- 0.014
ΔPtc	0.152	- 0.021	0.173	0.134	0.160	- 0.026	0.134	0.152	- 0.018

ΔInc	0.177	- 0.004	0.181	0.153	0.145	0.008	0.153	0.177	- 0.024
ΔUmc	0.037	- 0.026	0.063	0.034	0.126	- 0.092	0.034	0.037	- 0.003
Sample observations	96	19 957		87	87		87	96	

Note: *** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level, the same below; Columns (3), (6) and (9) are The mean t-test results; Δ is the difference between the variables lagging 1 period and lagging 2 periods.

There is no significant difference between the means of other matching variables, indicating that the samples after matching maintain a good balance. In order to test the representativeness of the sample after matching, columns (7) to (9) give the comparison results of the mean values of the enterprise characteristic variables of all digital M&A companies before matching and those of the post-matching processing group. There is no significant difference, indicating that the matched samples are relatively representative; the growth trends of innovation quantity and innovation quality of the two groups of enterprises have no significant difference before and after matching, indicating that the matching process has not affected the ex-ante innovation growth models of the two groups of enterprises . In addition, comparing the number of effective applications for invention patents and utility model patents in the current year and the 3-year citations of the two types of patents in columns (3) and (6), it is found that digital mergers and acquisitions are compared with non-digital mergers and acquisitions before the merger occurs. There are differences in the overall innovation performance of enterprises, but this difference is no longer significant after matching, which once again proves the balance of enterprise characteristics of the matched samples.

5. EMPIRICAL RESULTS AND ANALYSIS

5.1 OLS Estimation Results

Before causal inference, this study first observes whether digital mergers and acquisitions have differential innovation effects compared with non-digital mergers and acquisitions. The estimated results of OLS are shown in Table 2, which mainly compares the innovation promotion effect of digital mergers and Are there differences in the innovation effects of M&A and non-digital M&A? The sample observations in Table 2 are the sample observations at the enterprise-year level. Taking column (1) as an example, the 4,952 sample observations are composed of 96 digital M&A companies in the (T - 1) and T periods of 192 It consists of observations of samples and 4,760 observations of 2,380 companies that only have non-digital mergers and acquisitions in period (T - 1) and period T, and the rest of the columns are similar. Considering that the data in the OLS estimation results are unbalanced panels, the sample observations in period T, (T + 1) and (T + 2) periods are not exactly equal. From column (1) of Table 2.

Table 2 Estimation Results for OLS

	Number of innovations			innovation quality		
	T (1)	T + 1 (2)	T + 2 (3)	T (4)	T + 1 (5)	T + 2 (6)
Patent						
Dma • D	0.143	0.330**	0.491**	0.255**	0.424**	0.563**
	(0. 127)	(0. 141)	(0.223)	(0.129)	(0. 183)	(0.263)
goodness of fit	0.816	0.818	0.818	0.730	0.731	0.730
Utility model patents						
Dma • D	- 0.011	0.103	0.146	0.081	0.149	0.183
	(0.091)	(0.137)	(0.186)	(0.093)	(0. 116)	(0.212)
goodness of fit	0.791	0.789	0.791	0.729	0.729	0.728
control variable	control	control	control	control	control	control
Industry fixed effect× year fixed effect	control	control	control	control	control	control
firm fixed effects	control	control	control	control	control	control
Sample observations	4 952	4 941	4 934	4 952	4 941	4 934

Note: The data in brackets are the standard errors clustered to enterprises, the same below.

(3) It can be seen that from the perspective of the impact of digital mergers and acquisitions on the number of enterprise invention patents, the effect of digital mergers and acquisitions on the number of enterprise invention patents in the

current period of mergers and acquisitions is not obvious, but in the (T + 1) period and (T + 2) period The effect is remarkable. After coefficient conversion, the promotion rate of digital mergers and acquisitions is 39.097% (e0.330 - 1, the same algorithm below) and 63.395% higher than non-digital mergers and acquisitions; but from the impact of digital mergers and acquisitions on the number of utility model patents, The improvement effect of digital mergers and acquisitions is not significant in the three periods after mergers and acquisitions. Columns (4) to (6) of Table 2 show the impact of digital mergers and acquisitions on the innovation quality of enterprises. It can be seen that the quality of invention patents of enterprises in the current period of digital mergers and acquisitions has been significantly improved, and the improvement effect is 3 years after the merger. During the period, it continued to strengthen, and the promotion rate was 29.046%, 52.806% and 75.593% higher than that of non-digital M&A respectively. The results of the above OLS estimation do not involve causal inference. The following will use the matched samples for causal identification to accurately reveal the causal relationship between digital mergers and acquisitions and corporate innovation performance.

5.2 PSM-DID Estimation Results

5.2.1 The innovation effect of digital m&a

Before the difference-in-difference method is used to estimate the matched samples, it is considered that
When observing the change trend of innovation quantity and innovation quality before mergers and acquisitions, it is necessary to observe whether the trends of (T - 2) and (T - 1) are close to judge the rationality of the matching results. treatment group and control group) and the period before and after digital mergers and acquisitions (from (T - 2) period to (T + 2) period) to calculate the average value of enterprise innovation quantity and innovation quality to observe the change trend of enterprise innovation performance before and after digital mergers and acquisitions. Figure 3 shows the change trend of enterprise innovation quantity and innovation quality before and after digital mergers and acquisitions. In the (T - 2) period and (T - 1) period, the change trends of the innovation quantity and innovation quality of the two types of patents are very close, indicating that after matching The ex-ante innovation performance and change path of the two groups of enterprises maintain good similarity. since
From the period when digital mergers and acquisitions occurred, the differences in the quantity and quality of innovation between the two types of patents in the treatment group and the control group began to gradually increase, and this trend continued until the (T + 2) period.
The results of PSM-DID estimation of matched samples using formula (1).
As shown in Table 3, digital mergers and acquisitions have significantly improved the quantity and quality of invention patent innovation in the current period, and the effect on the quantity of innovation has declined slightly in the (T + 2) period, but the effect on the quality of innovation has accumulated year by year. Compared with the direct increase in the number of innovations brought about by the integration of mergers and acquisitions, the digital knowledge transfer and subsequent establishment of digital knowledge bases generated by digital mergers and acquisitions is a longer-term process of technology accumulation, and the technology spillover effects released by them will gradually increase the value of master-merger enterprises in the long run. quality of innovation. On average, digital mergers and acquisitions increase the number of invention patent innovations by 38.265% to 49.481%, and the improvement in innovation quality is as high as 59.042% to 99.771%. However, digital mergers and acquisitions did not have a significant impact on the innovation quantity and innovation quality of utility model patents. From the definitions of the two types of patents, an invention patent refers to a new technical solution proposed for a product, method or its improvement, and a utility model patent refers to a practical new technical solution proposed for the shape, structure or combination of a product , it can be seen that invention patents contain more innovative components and a deeper degree of innovation. The core target asset of digital mergers and acquisitions is digital technology. The impact of such technologies on corporate innovation is mainly in fundamental innovations, rather than additional innovations in product functions and structures. That is, the innovation effect of digital mergers and acquisitions exists between different types of patents. Heterogeneity does not significantly affect utility model patents. So far, this study has found that digital mergers and acquisitions mainly improve the quantity and quality of enterprise invention patents, that is, enterprises acquire advanced technologies of digital enterprises through digital mergers and acquisitions, continuously form digital knowledge accumulation and ultimately promote enterprise innovation performance. The research results are in line with the previous theoretical expectations, and H1 is verified.

Table 3 Estimation Results for PSM-DID

	Number of innovations			innovation quality		
	T	T + 1	T + 2	T	T + 1	T + 2
	(1)	(2)	(3)	(4)	(5)	(6)
Patent						
Dma • D	0.324**	0.402***	0.353**	0.464***	0.504***	0.692***
	(0.152)	(0.149)	(0.163)	(0. 170)	(0.189)	(0.190)
goodness of fit	0.034	0.052	0.028	0.042	0.040	0.117

Utility model patents						
Dma • D	0.084	0.196	0.171	0.137	0.195	0.315*
	(0. 128)	(0. 170)	(0.167)	(0. 128)	(0.152)	(0. 164)
goodness of fit	0.011	0.019	0.012	0.008	0.042	0.081
Sample observations	348	348	348	348	348	348

Note: The time of M&A transactions involved in the matching is from 2011 to 2016. Only the transactions in the completed state are kept and the first transaction of the company is selected. A total of 87 digital M&A transactions are matched. Since each comparison between the treatment group and the control group has two periods Therefore, the sample size is the number of digital M&A transactions after 1:1 matching multiplied by 4, a total of 348 sample observation values, the same below.

5.2.2 Differentiated innovation effects of domestic digital M&A and cross-border digital M&A

Cross-border digital mergers and acquisitions are not only cross-enterprise but also cross-border, which increases the risk and implementation difficulty of mergers and acquisitions, but there are still a certain proportion of cross-border digital mergers and acquisitions. In this study, two dummy variables Idm and Cdm are set. If Idm is a domestic digital M&A, the value is 1, otherwise it is 0; if it is a cross-border digital M&A, Cdm is 1, otherwise it is 0; Form an interaction term, replace Dma • D in formula (1) to re-estimate, and compare and analyze the difference in the innovation effect of domestic digital mergers and cross-border digital mergers and acquisitions. Table 4 shows the estimated results of PSM-DID for domestic digital M&A and cross-border digital M&A, which is consistent with the basic results. Both domestic digital M&A and cross-border digital M&A tend to improve the quantity and quality of enterprise invention patents, while the quantity and quality of utility model patents tend to increase. The impact on quality and quality has not reached the same level as that of invention patents. Taking invention patents as an example, this paper analyzes the causal effect of digital mergers and acquisitions on corporate innovation performance. In terms of the number of innovations, domestic digital mergers and acquisitions have already significantly increased the number of innovations of enterprises during the period when the mergers and acquisitions occurred.

Table 4 Estimation results of PSM-DID for domestic digital M&A and cross-border digital M&A

T (1)		Number of innovations			innovation quality	
		T + 1 (2)	T + 2 (3)	T (4)	T + 1 (5)	T + 2 (6)
Patent						
Idm • D	0.346** (0.151)	0.363**	0.306*	0.385**	0.440**	0.667***
		(0.152)	(0. 170)	(0. 172)	(0.195)	(0.199)
Cdm • D	0.155 (0.499)	0.705**	0.671**	1.069***	0.999***	0.867***
		(0.354)	(0.338)	(0.404)	(0.360)	(0.294)
goodness of fit	0.035	0.058	0.034	0.061	0.050	0.119
Utility model patents						
Idm • D	0.071 (0. 119)	0.161	0.138	0.108	0.150	0.321*
		(0. 178)	(0.179)	(0. 123)	(0.162)	(0. 174)
Cdm • D	0.177 (0.540)	0.460	0.400*	0.361	0.545***	0.275
		(0.334)	(0.230)	(0.488)	(0.184)	(0.317)
goodness of fit	0.012	0.022	0.015	0.012	0.050	0.081
Sample observations	348	348	348	348	348	348

Significant promotion effect, this is because the target company in cross-border mergers and acquisitions is generally geographically far away from the main merged company, and there are varying degrees of differences in systems and cultures, making mergers and acquisitions more difficult to integrate, so the number of innovations has increased Inevitably there is a hysteresis effect. Existing studies on Chinese listed companies have also found that the innovation effect of cross-border M&A is not significant in the current period of M&A, but gradually emerges in the later stage of M&A [8]. In terms of innovation quality, domestic digital M&A and cross-border digital M&A both promote the improvement of corporate innovation quality, but the improvement effect of cross-border digital M&A is relatively stronger. As mentioned earlier in this study, cross-border mergers and acquisitions are conducive to the merger and acquisition of enterprises to choose the knowledge they need from a larger and more diverse resource pool, so that they can obtain more complementary and strategic knowledge and generate greater profit. Synergies and technological

knowledge spillover effects [8]. In addition, the availability of digital technology makes it easier to realize the derivative innovation expanded by technology integration and recombination [17]. Therefore, in technology-seeking mergers such as digital mergers and acquisitions, the technological improvement advantages of cross-border mergers and acquisitions are more obvious. Overall, the research results are in line with the previous theoretical expectations, and H2 has been verified.

6. HETEROGENEITY TEST

6.1 Heterogeneity of M&A Types

The value creation process among the digital economy industries and their relationship with the Internet are actually quite different. The business models of some industries are completely based on the Internet, and their products and services are all based on the Internet, with digital and virtualization, etc. It belongs to the online service digital industry, which is different from the non-online service digital industry that involves the production and sales of offline physical products, that is, the non-online service digital industry with some traditional manufacturing properties. Based on this, this study divides digital mergers and acquisitions into online and offline digital mergers and acquisitions at the transaction level according to their target industries. Online digital mergers and acquisitions involve 13 industries, and offline digital mergers and acquisitions involve the remaining 13 industries. Then set the dummy variable Onl, which belongs to online digital mergers and acquisitions. The value of Onl is 1, which belongs to non-online digital mergers and acquisitions.
The value of Onl is 0, and Onl and Dma • D form a triple interaction item and add
(1) formula to estimate. Table 6 shows the results of the heterogeneity analysis of M&A types. The effect of online digital M&A on improving the number of innovations of enterprises only passes the significance test at the 5% level in the current period of M&A, but from the (T + 1) period onwards The improvement effect of innovation quality is significantly stronger than that of offline digital mergers and acquisitions. This study believes that offline digital technology is mostly digital empowerment for a certain link, such as robots assisting intelligent manufacturing, and the Internet of Things is conducive to digital intelligence in the supply chain, etc.; while online digital technology is often more cutting-edge and universal, that is, it can It is more applied to different scenarios. For example, the management system based on big data and artificial intelligence can coordinate the operation of various links such as production, manufacturing and sales, and help enterprises better improve the degree of digitalization and transform business models. Therefore, online digital mergers and acquisitions The innovation effect brought about is stronger.

Table 6 Heterogeneity Analysis: Online and Offline Digital M&As

	Number of innovations			innovation quality		
	TT + 1 T + 2 (1) (2) (3)			T (4)	T + 1 (5)	T + 2 (6)
Dma • D	0.021 0.213 - 0.038 (0. 198) (0. 199) (0.273)			0.241 - 0.005 0.206 (0.232) (0.242) (0.289)		
Dma • D •	0.471** 0.257 0.499*			0.346 0.693*** 0.622**		
Onl	(0.227) (0.212) (0.281)			(0.243) (0.248) (0.284)		
goodness of fit	0.058 0.058 0.046			0.053 0.069 0.136		
Sample observations	348 348 348			348 348 348		

6.2 Heterogeneity of Enterprise Types

6.2.1 Digital enterprises and non-digital enterprises
At the enterprise level, this research divides the M&A companies into digital enterprises and non-digital enterprises according to whether they are in the digital economy industry. The dummy variable Dig is set. Dig is 1 for digital enterprises and 0 for non-digital enterprises. When the value is 0, Dig and Dma • D form a triple interaction item and add it to Equation (1) for estimation. The results show that although there is no significant difference in the short-term innovation benefits obtained by digital companies and non-digital companies after digital mergers and acquisitions, considering that digital companies have more original digital knowledge stocks and face a smaller digital technology gap, their In the process of digital technology integration, the performance is better than that of non-digital enterprises, and in the long run ((T + 2) period), they have achieved higher innovation quality improvement. In addition, although the widespread use of digital technology has greatly eased the difficulty of integrating differentiated digital technologies for mergers and acquisitions from the perspective of technical attributes, whether digital mergers and acquisitions can have a strong innovation effect on companies still depends on the mergers and acquisitions' own absorptive capacity and The ability to integrate digital technology depends on the degree of overlap between the knowledge base of the

acquirer and the target [18]. When the acquirer has formed a certain digital capability through the accumulation of original digital knowledge, it will reduce the difficulty of integrating digital technology, so as to promote the reorganization and creation of knowledge by the acquired enterprise, and finally improve the technical level [26]. 5.2.2 State-owned enterprises and non-state-owned enterprises

In addition to the technical characteristics of acquired companies, the degree of acceptance of emerging technologies and new business formats is also one of the factors that affect the integration and re-innovation of digital technology. Most state-owned enterprises are in the pillar industries of the national economy. Considering the purpose of protecting national economic security, state-owned enterprises will face stronger selection constraints when implementing digital mergers and acquisitions. In this study, the dummy variable Soe is set, the value of Soe for state-owned enterprises is 1, and the value of Soe for non-state-owned enterprises is 0. Soe and Dma • D constitute a triple interaction item to be added to Equation (1) for estimation. The results show that although there is no significant difference in the promotion effect of digital mergers and acquisitions of state-owned enterprises on the innovation quantity of enterprises and non-state-owned enterprises, in the long run ((T + 2) period), the promotion effect of digital mergers and acquisitions on the innovation quality of state-owned enterprises is significantly lower than that of non-state-owned enterprises. non-state-owned enterprises. This suggests that state-owned firms are less capable of maintaining high-quality innovation than non-state-owned firms after digital M&A. Xian Guoming et al. [7] also reached the same conclusion. They believed that state-owned enterprises may affect innovation efficiency and reduce innovation sustainability by undertaking goals other than profit, and ultimately affect their long-term innovation capabilities. This point of view can also be very good For digital mergers and acquisitions.

7. INFLUENCE MECHANISM TEST

7.1 Knowledge Synergy

Digital mergers and acquisitions, accompanied by the integration of digital technology and digital management experience and other intangible assets, increase the intellectual capital of merged companies, help companies accumulate technical knowledge, and strengthen knowledge synergy under the new pattern of "winner takes all" in the digital economy . This study uses the proportion of intangible assets in total assets to measure knowledge stock (KS), and uses the ideas of Li Jintian et al. [45] to test the impact mechanism. Table 7 shows the estimated results after adding the knowledge stock. From the results in columns (1) to (3), it can be seen that digital mergers and acquisitions significantly promote the accumulation of knowledge stocks of acquired companies, and this effect still plays a role in the later stage of mergers and acquisitions. Further, from the results of columns (4) to (9), we can see that the knowledge synergy effect significantly promotes the increase in the number of enterprise innovations in the T period and (T + 1) period, but it is not significant in the (T + 2) period. The effect of improving the quality of enterprise innovation is limited. Overall, the research results are roughly in line with the previous theoretical expectations, and H3a has been verified.

In fact, the significant knowledge synergy effect in the short term reflects to a certain extent the direct and efficient acquisition of digital technology through digital mergers and acquisitions, a property rights transaction method. The reverse technology spillover effect can play a better role in the current period of mergers and acquisitions; With the integration of technology and resources, the maintenance and enhancement of knowledge synergy depends more on the enterprise's own digital technology integration capabilities.

Table 7 Mechanism Analysis: Knowledge Synergetic Effect

		KS			Number of innovations			innovation quality	
T		T + 1	T + 2	T	T + 1	T + 2	T	T + 1	T + 2
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dma • D	0.061***	0.062***	0.063***						
	(0.015)	(0.018)	(0.019)						
KS				2.398*	2.914**	1.824	1.212	1.637	1.467
				(1.240)	(1. 137)	(1.275)	(1.274)	(1.393)	(1.374)
goodness of fit	0.232	0.257	0.244	0.024	0.036	0.012	0.005	0.007	0.005
Sample observations	348	348	348	348	348	348	348	348	348

7.2 Financial Synergies

The indirect financing behavior of listed companies in the secondary market is very common. In order to verify the financial synergy effect of digital mergers and acquisitions, this study uses the company’s price-earnings ratio to

measure the company's financing ability, and the company's profit before interest, taxes, depreciation and amortization plus 1 and taking the logarithm to measure the company's profit ability. The regression results of adding enterprise price-earnings ratio show that digital mergers and acquisitions have significantly improved the financing ability of enterprises, and the choice of payment methods for digital mergers and acquisitions has not created a heavy financing burden for mergers and acquisitions as a whole, but has strengthened the financing ability of mergers and acquisitions in the secondary market. The regression results of adding corporate earnings before interest, taxes, depreciation and amortization show that digital mergers and acquisitions can also strengthen the profitability of mergers and acquisitions. Further, from the perspective of the impact of corporate price-earnings ratio and EBITDA on the quantity and quality of innovation, the improvement of financing ability can significantly improve the innovation performance of enterprises, and the improvement of profitability can improve the innovation performance of enterprises in the second period after mergers and acquisitions. It is also reflected. In general, digital mergers and acquisitions form financial synergy effects by improving corporate financing capabilities and profitability, and ultimately improve corporate innovation performance. Therefore, H3b is verified.

8. CONCLUSION

8.1 Research Results

This study investigates the innovation effect of digital mergers and acquisitions on mergers and acquisitions, selects Chinese listed companies as research samples, and conducts empirical research on their digital mergers and patent data from 2009 to 2018, and obtains the following research results:

(1) Whether it is domestic or cross-border digital mergers and acquisitions, it can increase the quantity of innovations of the acquired companies, and can even improve the quality of their innovations. Compared with domestic digital mergers and acquisitions, cross-border digital mergers and acquisitions have a certain lag in improving the quantity of innovation, but the effect on improving the quality of innovation is significantly greater. On the one hand, the transfer of digital knowledge generated by cross-border digital mergers and acquisitions is constrained by geographical distance, institutional and cultural differences between enterprises, and technology integration takes longer and is more difficult; More diverse digital technology resource pools are available, so they often produce stronger innovation effects [8], and this effect is more prominent in the subsequent long-term establishment and enrichment of digital knowledge bases.

(2) The innovation effect of digital M&A is heterogeneous in three aspects: whether it is an online digital M&A, whether the master merger is a digital enterprise, and whether it is a state-owned enterprise. ① Offline digital technology focuses on digital empowerment of a certain link, and the application scenarios are relatively fixed; online digital technology is more cutting-edge and universal, and the application scenarios are broader. Therefore, the innovation effect of online digital mergers and acquisitions is stronger. ②Digital enterprises have more original digital knowledge stock and smaller digital divide. They perform better in digital technology integration in the later stage of digital mergers and acquisitions, and it is easier to improve the quality of innovation. ③ Potential non-profit goals reduce the innovation efficiency and innovation sustainability of state-owned enterprises, making the ability of state-owned enterprises to maintain high-quality innovation weaker than non-state-owned enterprises, which is not conducive to improving their long-term innovation performance [7].

(3) Knowledge synergy and financial synergy are two important mechanisms for digital M&A to improve corporate innovation performance. With the gradual integration of intangible assets such as technical knowledge, management experience and marketing network, on the one hand, it will increase the knowledge stock of the acquired company, help to improve its productivity and resource allocation efficiency, and generate knowledge synergy; on the other hand, it can also Improve the economies of scale or scope of products, boost the profit margin and valuation of the company, improve the financing flexibility of its future transactions, and generate financial synergy. Further empirical results show that the improvement of knowledge stock, profit rate and valuation can further improve the innovation performance of enterprises.

8.2 Theoretical Contributions

① This study discusses the impact of domestic digital mergers and acquisitions and cross-border digital mergers and acquisitions on the quantity and quality of corporate innovation. On the one hand, the existing relevant research pays little attention to both domestic and cross-border M&A types. On the other hand, the discussion on digital M&A still stays at the level of a certain industry or a specific M&A case, and does not focus on the special case of digital M&A. The type of M&A as a whole is deeply explored. To a large extent, this study is a beneficial supplement to the existing research, expanding the scope of research in the field of mergers and acquisitions. ② This study examines the heterogeneous impact of digital mergers and acquisitions on corporate innovation performance based on digital technology characteristics such as online digital mergers and acquisitions and digital enterprises. Existing studies mainly focus on the impact of general technical characteristics such as patent-intensive and high-tech enterprises rather than digital technology characteristics on corporate innovation performance [6,9]. Taking the characteristics of digital technology as the starting point, this study expands the dimension of heterogeneity analysis of enterprise innovation research. ③ In terms of impact mechanism, existing studies mainly focus on the R&D mechanism of increasing R&D investment and improving R&D efficiency [6-7]. This study combines the characteristics of digital mergers and

acquisitions to empirically test the two influence paths of knowledge synergy and financial synergy , better revealed the internal mechanism of digital mergers and acquisitions affecting corporate innovation performance, and deepened the theoretical understanding of the field of digital mergers and acquisitions.

8.3 Practical Enlightenment

① Enterprises should formulate long-term digital development strategies, consciously search for suitable digital targets, increase digital mergers and acquisitions, and strengthen digital empowerment and innovation transformation. During this process, enterprises should pay attention to protecting the integrity of digital assets and avoid the loss of key technical and management personnel caused by over-integration. For this reason, the enterprise can maintain the relative independence of the target enterprise, and only provide support in non-core links such as finance and operation, so as to fully ensure the sustainable development of the technology research and development link. At the same time, enterprises need to pay attention to the process of digital technology accumulation after digital mergers and acquisitions, actively promote the establishment and enrichment of their own digital knowledge bases, better leverage the innovative effects of digital mergers and acquisitions, and maximize the value of mergers and acquisitions. In addition, enterprises should also cultivate professional digital teams to be responsible for docking and coordinating the collaborative innovation of digital technology and their own technology, so as to further enhance the knowledge synergy effect of digital mergers and acquisitions. ②Local governments should be aware of the role and importance of digital mergers and acquisitions in accelerating innovation for enterprises, strengthen guidance and support for digital mergers and acquisitions of enterprises, and create a good business environment for local enterprises as much as possible to alleviate the financing difficulties of corporate mergers and acquisitions, thereby reducing financial costs. The negative effect of the burden on corporate innovation activities. At the same time, local governments should also focus on cultivating highly innovative unicorn companies and leading companies in the industry, so as to drive the agglomeration and common progress of the local digital industry. ③The post-epidemic era will still be shrouded in the haze of anti-globalization. In the face of more intense competition among countries, especially the policy uncertainty of China and the United States, the country should introduce relevant policies to accelerate the formation of domestic and international dual cycles A mutually reinforcing digital investment and development pattern ensures that while acquiring overseas advanced digital technologies as much as possible to feed back domestic enterprises,

COMPETING INTERESTS

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REFERENCES

[1] Blackburn S. Digital disruption and the role of M&A. 2020, 06. https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/ our-insights/digital-disruption-and-the-role-of-m-and-a/.
[2] Haucap J, Rasch A, Stiebale J. How mergers affect innovation: theory and evidence. International Journal of Industrial Organization, 2019, 63: 283-325.
[3] Zhu Zhili, Wen Jun, Li Jin. Overseas M&A, culture distance and technology innovation. Modern Economic Science, 2016, 38(2): 79-86,127.
[4] Denicolò V, Polo M. Duplicative research, mergers and innovation. Economics Letters, 2018, 166: 56-59.
[5] Ren Shuming, Xu Mengjie, Wang Qian. M&A and firm' s R&D: evidence from Chinese listed manufacturing firms. China Industrial Economics, 2017(7): 137- 155.
[6] Zhang Wenfei, Jin Xiangyi, Zhang Cheng. Transnational mergers and acquisitions, marketing degree and enterprise innovation: empirical evidence from listed companies. Nankai Economic Studies, 2020(2): 203-224.
[7] Xian Guoming, Ming Xiunan. Cross broad merger and innovation of acquiring firms. Journal of Financial Research, 2018(8): 155- 171.
[8] Chen Aizhen, Zhang Pengfei. M&A mode and enterprise′ s innovation. China Industrial Economics, 2019(12): 115-133.
[9] Li Chuntao, Yan Xuwen, Song Min. FinTech and corporate- ate innovation: evidence from Chinese NEEQ-listed companies. China Industrial Economics, 2020(1): 81-98.
[10] Yoo Y, Boland Rj, JR, Lyytinen K. Organizing for innovation in the digitized world. Organization Science, 2012, 23(5): 1398- 1408.
[11] Yoo Y, Henfridsson O, Lyytinen K. Research commentary: the new organizing logic of digital innovation: an agenda for information systems research.Information Systems Researchch, 2010, 21(4): 724-735.
[12] Gao LS, Iyer B. Analyzing complementarities using software stacks for software industry acquisitions. Journal of ManagementInformation Systems, 2006, 23(2): 119- 147.
[13] Makri M, Hitt MA, Lane P J. Complementary technologies, knowledge relatedness, and invention outcomes in high technology mergers and acquisitions. Strategic Management Journal, 2010,31(6): 602-628.
[14] Hanelt A, Firk S, Hildebrandt B. Digital M&A, di-digital innovation, and firm performance: an empirical investigation.European Journal of Information Systems, 2021, 30(1): 3-26.

[15] Ranft AL, Lord M.D. Acquiring new technologies and capabilities: a grounded model of acquisition implementation. Organization Science, 2002, 13(4): 420-441.
[16] Ciriello RF, Richter A, Schwabe G. Digital innovation. Business & Information Systems Engineering, 2018, 60(6): 563-569.
[17] Nylén D, holmström J. Digital innovation strategy: a frame-work for diagnosing and improving digital product and service in-novation.Business Horizons, 2015, 58(1): 57-67.
[18] Hinings B, Gegenhuber T, Greenwood R. Digital innovation and transformation: an institutional perspective. Informationand Organization, 2018, 28(1): 52-61.
[19] Yoo Y. Computing in everyday life: a call for research on experiential computing. MIS Quarterly, 2010, 34(2): 213 -231.
[20] Henfridsson O, Nandhakumar J, Scarbrough H. Recombination in the open-ended value landscape of digital in-novation.Information and Organization, 2018, 28(2): 89- 100.
[21] Dong JQ, Yang C H. Information technology and innovation outcomes: is knowledge recombination the missing link?. EuroPean Journal of Information Systems, 2019, 28(6): 612-626.
[22] Bertrand O, Zuniga P. R&D and M&A: are cross-border M&A different? An investigation on OECD countries. International Journal of Industrial Organization, 2006, 24(2): 401-423.
[23] Chidambaran NK, Krishnakumar D, SETHI M. Cross-border vs. domestic acquisitions: evidence from India. Journal of Economics and Business, 2018, 95: 3-25.
[24] Nocke V, Yeaple S. Cross-border mergers and acquisitions vs. greenfield foreign direct investment: the role of firm heterogeneity. Journal of International Economics, 2007, 72(2): 336-365.
[25] Norbäck PJ, Persson L. Investment liberalization: why a re-strictive cross-border merger policy can be counterproductive.Journal of International Economics, 2007, 72(2): 366-380.
[26] Erel I, Liao RC, Weisbach M S. Determinants of cross-border mergers and acquisitions.The Journal of Finance, 2012, 67(3): 1045- 1082.
[27] Ahuja G, Katila R. Technological acquisitions and the innova-tion performance of acquiring firms: a longitudinal study. StrategicManagement Journal, 2001, 22(3): 197-220.
[28] Anderson J, Sutherland D, SEVERE S. An event study of home and host country patent generation in Chinese MNEs under-taking strategic asset acquisitions in developed markets. International, 2015, 24(5): 758-771.
[29] Stiebale J, Vencappa D. Acquisitions, markups, efficiency, and product quality: evidence from India. Journal of InternationalEconomics, 2018, 112: 70-87.
[30] Morellec E, Zhdanov A. Financing and takeovers. Journalof Financial Economics, 2008, 87(3): 556-581.
[31] Jiang Guanhong. Cross-border merger and acquisitions of Chinese firms is failed or not: evidence from effective of industrial firms. Journal of Financial Research, 2017(4): 46-60.
[32] Boote J, Harper A, Nielsen J. Cracking the code of digital M&A. 2019, 02. https://www.bcg.com/publications/2019/cracking-code-digital-m-and-a.
[33] Leroi A, Miles L, Spaulding E. The changing rules for digital M&A. 2017, 02. https://www.bain.com/insights/the-changing-rules-for-digital-m-and-a/.