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THE IMPACT OF DIGITAL MERGERS AND ACQUISITIONS ON TOTAL FACTOR PRODUCTIVITY UNDER THE CULTIVATION OF NEW QUALITY PRODUCTIVITY

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Abstract: In the context of the digital age, the cultivation of new quality productivity has become the key to promoting high-quality economic development.This article aims to explore how digital mergers and acquisitions, under the cultivation of new quality productivity, can increase the number of patents through innovative technologies and innovate business models, thereby affecting the overall factor productivity of enterprises.This study uses digital mergers and acquisitions events of Chinese A-share listed companies from 2015 to 2022 as samples, and uses multiple regression analysis to systematically examine the impact and mechanism of digital mergers and acquisitions on total factor productivity of enterprises.The study found that firstly, digital mergers and acquisitions significantly improved the total factor productivity of enterprises, and this effect gradually emerged and remained stable within two years after the merger.Secondly, through technological synergies, digital mergers and acquisitions have promoted the improvement of corporate innovation capabilities and optimized resource allocation efficiency.In addition, digital mergers and acquisitions enhance the market competitiveness and customer value creation ability of enterprises through innovative business models.Heterogeneity analysis shows that digital mergers and acquisitions of non-state-owned enterprises have a more significant effect on improving their total factor productivity.
This study not only enriches the relevant theories of digital mergers and acquisitions and enterprise productivity, but also provides empirical basis for the government and enterprises to formulate relevant policies and strategies in the process of digital transformation.Future research can further explore the long-term effects of digital mergers and acquisitions and their mechanisms in different industry contexts.
Keywords: Digital mergers and acquisitions; New quality productivity; Total factor productivity

1 INTRODUCTION

The scale of China's digital economy has continued to expand in recent years, with a growth rate significantly higher than the GDP growth rate during the same period. In 2023, the digital economy will account for 42.8% of GDP and contribute 66.45% to GDP growth. The digital economy is gradually developing into an important support for new quality productivity, promoting high-quality economic development through technological innovation and integrated applications.The improvement of total factor productivity in the digital economy is a core indicator of the accelerated formation of new quality productivity.In addition, the digital economy plays an important role in innovation driven, integrated empowerment, and the release of data element value, and is closely connected to other fields.The rapid development of the digital economy has provided strong impetus and technological support for the digital transformation of enterprises, promoting the in-depth development of digital transformation in enterprises.According to data from Light up Think Tank and CITIC Union, as of 2023, 10.15% of enterprises in China have undergone substantial transformation, and nearly 90% of enterprises have focused their digital transformation efforts on achieving standardized business operations and management through information technology applications. According to the "China Small and Medium sized Enterprises Digital Transformation Report 2024", 62.6% of small and medium-sized enterprises are still in the early stages of digitalization, and the digital transformation index level of large enterprises is 40% higher than that of small enterprises [1]. In addition to differences in enterprise size, there are also differences in the digital transformation process between industries.For example, industries such as communication, electronics, and petrochemicals are in the first tier of digital transformation, while industries such as food, building materials, light industry, and construction are relatively lagging behind.In recent years, although digital transformation has been a common trend for enterprises, there are still some problems in the process of combining it with the development of the digital economy.The main focus is on the uneven level of digitalization, insufficient integration of technology and business, insufficient protection of data security and privacy, and high cost of digital transformation. Therefore, it requires joint efforts from the government, enterprises, and all sectors of society to strengthen cooperation and investment in policy guidance, talent cultivation, and other aspects [2]. Digital mergers and acquisitions are an important way for enterprises to gain technological advantages and achieve transformation and upgrading in the digital economy era. For example, Wentai Technology adopted a "two-step" transaction approach and successfully acquired control of Anshi Semiconductor. After the merger, Wentai Technology accelerated its layout and expansion in emerging markets by leveraging its advanced technology and management experience. Through mergers and acquisitions, it effectively integrated upstream and downstream resources in the semiconductor industry chain, optimized resource

allocation, more efficiently utilized production factors, improved production efficiency and product quality, and thus enhanced overall productivity.Compared with 2015, in 2018, Wentai Technology saw a 53.65% decrease in asset investment and a 1281.46% increase in human resources investment. However, its operating revenue and profit increased by 2321.07% and 149.10% respectively. Its output growth rate was much higher than the input growth rate, and the company's total factor productivity significantly improved [3].

The new quality productivity is marked by the improvement of total factor productivity, and the core is innovation.In the context of the digital economy, the new quality productivity takes scientific and technological innovation as the essence of promoting industrial innovation, and takes the substantial improvement of total factor productivity as the goal. It strengthens the integration and application of digital technologies such as artificial intelligence, big data, the Internet of Things, and the industrial Internet, and uses data development and utilization as the engine to promote the innovative allocation of production factors, and promote the birth of new industries, new models, and new drivers.In the new industrial system, the industrial format model is constantly updated and developed, and the industrial chain is gradually expanding [4]. New quality productivity, with technological innovation as its core, provides a technological foundation and driving force for digital mergers and acquisitions, while also providing direction for the improvement of total factor productivity.In terms of theoretical research on "new quality productivity", current studies mainly focus on philosophical and political economic perspectives as well as mainstream economic theories. From the perspective of Marxist materialist conception of history, starting from the perspective of "productivity production relations", combined with the actual development of China's industrial economy, it is believed that the essence of developing new quality productivity is a qualitative change in economic development, with the core being to improve total factor productivity [5]. Furthermore, from the perspective of evolutionary economics, knowledge production and diffusion have been the endogenous driving forces behind the development of new quality productive forces since the Industrial Revolution.Among them, the collaborative evolution of technological systems and organizations plays a very important role.In terms of practical application, new quality productivity has been explored in areas such as technological equipment innovation, vocational education services, and international trade rules, but there is relatively little research on digital mergers and acquisitions.

- Digital M&A refers to a strategic choice for enterprises to use digital technology and platform economy mode to promote digital transformation of enterprises and enhance their competitiveness and innovation ability through acquisition, merger or equity investment. The rise of the Internet economy has broken the traditional industrial boundaries and promoted digital transformation and innovation in all walks of life.Traditional enterprises are facing enormous competitive pressure, while also gaining opportunities for digital mergers and acquisitions.By acquiring or investing in Internet enterprises, traditional enterprises can quickly acquire new markets, new channels and new technologies, and accelerate the process of digital transformation [6].In the process of digital transformation, enterprises need to continuously acquire advanced digital technologies and talents, and digital mergers and acquisitions have become an important means for enterprises to achieve digital transformation and enhance competitiveness.The role of digital mergers and acquisitions in cultivating new quality productivity is mainly manifested in five aspects, namely technology acquisition and innovation, market expansion and channel optimization, talent and resource aggregation, corporate culture and strategic synergy, and promoting industrial transformation and upgrading.Regarding digital mergers and acquisitions, through relevant research on digital mergers and acquisitions, many studies have mainly focused on its effect mechanisms, driving trends, merger models, and strategies, reflecting the important position of digital mergers and acquisitions in digital economic activities.From the perspective of research on the impact of digital mergers and acquisitions, existing studies have explored its effects on corporate performance, digital transformation, innovation performance, and digital platform economic performance. Digital mergers and acquisitions provide data support for improving corporate innovation performance and promoting digital transformation.There is relatively little research on the impact of digital mergers and acquisitions on total factor productivity, and most of it focuses on the theoretical level.In November 2024, Guotai Junan and Haitong Securities announced their merger and reorganization, which received approval from the Shanghai State owned Assets Supervision and Administration Commission, and released a draft merger and reorganization report.Both companies are leading securities firms in China, and the merger will form an investment bank with stronger capital strength.The capital strength of the newly merged company has significantly increased, with both net assets and net capital ranking first in the industry.Stronger capital strength will significantly enhance the risk tolerance of the merged company, improve capital utilization efficiency and fund utilization effectiveness.At the same time, both companies will establish new corporate governance structures, management structures, development strategies, and corporate cultures to promote effective business integration and enhance overall profitability. These changes are expected to drive the improvement of total factor productivity.

At present, domestic and foreign scholars' research on digital mergers and acquisitions mainly focuses on their motives and performance, and has added some new theories for analysis.In foreign research, the main direction of motivation research is the Ecological Environment Specific Advantage Theory (ESA) and externalization logic. ESA theory believes that the motivation for mergers and acquisitions of digital enterprises is not only to save transaction costs, but also to acquire and utilize external resources to maintain ecological environment advantages. The study of externalization logic refers to the tendency of digital enterprises to acquire external resources through mergers and acquisitions.In terms of performance research, foreign scholars have analyzed the performance of digital mergers and acquisitions through methods such as case studies and event study.Some studies have found that digital mergers and acquisitions can improve corporate performance, especially in the short term;But there are also some studies indicating that it may bring certain risks and uncertainties, which require companies to carefully evaluate.

In the study of the driving forces behind digital mergers and acquisitions in China, it has been found that the main reasons are due to the demand of traditional enterprises for digital transformation, market expansion, and resource integration. In addition, domestic scholars have used methods such as principal component analysis, event study, and factor analysis to study the performance of digital mergers and acquisitions. They have also found that digital mergers and acquisitions can improve corporate performance or pose risks in the medium to long term.It can be seen that there is still limited research on the impact of digital mergers and acquisitions on total factor productivity.

The factors that affect total factor productivity are complex and diverse, and existing research has mainly explored them from the aspects of financial development level, technological innovation, labor market, etc.Total factor productivity is an important indicator for measuring the quality and efficiency of economic development, reflecting the comprehensive utilization efficiency of various input factors in the production process.Improving total factor productivity is an important way to enhance the efficiency of resource allocation in state-owned enterprises and promote their high-quality development.Ouyang Zhigang et al. explored the issue of resource allocation and total factor productivity from the perspective of debt finance based on the realistic background of financial resource allocation in China's manufacturing industry, and analyzed the relationship between different types of enterprises [7].TFP, as a key indicator for measuring the production efficiency of enterprises, its improvement is the core for enterprises to achieve sustainable development and enhance market competitiveness.There is a close relationship between new quality productivity, digital mergers and acquisitions, and total factor productivity.New quality productivity, with technological innovation as its core, provides a technological foundation and driving force for digital mergers and acquisitions, while also providing direction for the improvement of total factor productivity.Digital mergers and acquisitions, as a way for companies to expand, promote innovation and development by acquiring new technologies, increasing market share, and other motivations. They provide a pathway for companies to innovate their business models, thereby improving total factor productivity.The improvement of total factor productivity, in turn, provides an economic foundation and driving force for the development of new quality productivity.

This study first analyzed the connotation of digital mergers and acquisitions and the current research status of digital mergers and acquisitions at home and abroad, and then systematically sorted out the theories and literature on the relationship between digital mergers and acquisitions and TFP.On the basis of this theoretical construction, this article proposes research hypotheses, using digital merger and acquisition events of Chinese A-share listed companies from 2015 to 2022 as samples, designing a benchmark regression model to study the linear relationship between independent and dependent variables, and finally, using panel data regression analysis method to conduct in-depth research and testing.

The research contribution of this article mainly lies in its theoretical and practical significance.

In terms of theoretical contribution, it is mainly reflected in the enrichment and development of productivity theory on digital mergers and acquisitions under the new quality productivity, deepening the research on types of corporate mergers and acquisitions, and expanding the theory of total factor productivity.

Firstly, although research has confirmed that digital mergers and acquisitions have a promoting effect on total factor productivity of enterprises, most of these studies focus on the synergies and human capital effects brought about by digital mergers and acquisitions.Liu Weilin et al. explored the network effects of total factor productivity growth and transmission measurement based on the global production network, reflecting the total factor productivity growth and spillover effects at the national and industrial levels under the dual circulation condition [8].This article incorporates technological innovation and business model innovation into the analytical framework, further refining the impact path of digital mergers and acquisitions on total factor productivity of enterprises, and enriching the research content in this field.

Secondly, traditional research on corporate mergers and acquisitions mainly focuses on technology mergers and acquisitions, green mergers and acquisitions, and other aspects, while there is relatively little research on corporate mergers and acquisitions behavior from the perspective of digital technology.This article takes digital mergers and acquisitions as the research object, exploring their mechanism in improving the total factor productivity of enterprises, which helps to expand the relevant research on the types of corporate mergers and acquisitions from the perspective of digital technology.

Thirdly, total factor productivity is an important indicator for measuring economic growth efficiency and technological progress, and its influencing factors are complex and diverse.This article incorporates digital mergers and acquisitions into the analytical framework, exploring their impact on total factor productivity from the perspectives of technological and business model innovation. This will help enrich the research on factors affecting productivity and provide a new theoretical perspective for improving enterprise production efficiency.

In practical terms, the research on the impact of digital mergers and acquisitions on total factor productivity under the new quality productivity mainly reflects three aspects: guiding the digital transformation of enterprises, optimizing resource allocation efficiency, and providing scientific basis for policy systems.

- Firstly, this study is of great significance in guiding the digital transformation of enterprises.By revealing the role of digital mergers and acquisitions in improving total factor productivity, this study provides an effective way for companies to acquire digital technologies and services through mergers and acquisitions, build digital capabilities, and enhance competitive advantage and corporate performance.This helps companies better adapt to the development environment of the digital economy and achieve efficient and sustainable development.

Secondly, by analyzing the impact mechanism of digital mergers and acquisitions on total factor productivity, the research results of this article help enterprises recognize the role of digital mergers and acquisitions in optimizing

resource allocation and improving economic efficiency, thus enabling more scientific resource allocation and production management.

Thirdly, this study has important reference value for the government to formulate relevant policies.New quality productivity is a productivity leap caused by a new round of technological revolution represented by intelligent and green technologies, characterized by disruptive innovation driven, fast development speed, and high development quality.By enhancing total factor productivity through digital mergers and acquisitions, the government can encourage digital M&A activities by introducing relevant policies, and strengthen supervision and guidance of digital M&A activities to ensure their healthy development.

2 THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

There are some key differences between traditional digital mergers and acquisitions and digital mergers and acquisitions under the cultivation of new quality productivity in terms of goals, processes, and outcomes.In terms of target differentiation, traditional digital mergers and acquisitions typically focus on acquiring specific digital assets, technologies, or user bases to enhance existing businesses or enter new markets, with the goal of achieving short-term financial gains and increasing market share.Under the cultivation of new quality productivity, digital mergers and acquisitions tend to promote long-term technological innovation and productivity development through mergers and acquisitions. The goal of cultivating new quality productivity includes not only financial returns, but also enhancing the core competitiveness, innovation capability, and sustainable development capability of enterprises.In terms of process differences, Traditional digital mergers and acquisitions may focus more on short-term improvements in financial and market performance, while post merger integration may primarily focus on cost savings and revenue growth. In contrast, the overall process of digital mergers and acquisitions under the cultivation of new quality productivity tends to emphasize the integration of technology and innovation capabilities, as well as long-term R&D investment, talent cultivation, and innovation culture construction.Overall, as an important form for enterprises to acquire digital technology in the digital economy era, digital mergers and acquisitions have stronger digital technology requirements compared to traditional mergers and acquisitions. Enterprises hope to directly acquire new technological resources through mergers and acquisitions, reduce their own research and innovation risks, and accelerate digital transformation.Under the cultivation of new quality productivity, digital mergers and acquisitions pay more attention to long-term technological innovation and productivity development, while traditional digital mergers and acquisitions may focus more on short-term financial and market goals.Under the cultivation of new quality productivity, enterprises not only acquire technology and market resources through digital mergers and acquisitions, but also achieve sustainable competitiveness enhancement through integration and innovation.Research hypothesis 1: Digital mergers and acquisitions can effectively improve total factor productivity

Digital M&A refers to the merger and acquisition activities of companies in order to acquire digital technology, talent, data assets, or other related resources.This type of merger and acquisition activity is becoming increasingly important in the context of digital transformation and digital economy.Total factor productivity (TFP) refers to the rate at which output increases while the input of all production factors (such as labor, labor capital, land, etc.) remains constant. It is influenced by technological progress, human capital, resource allocation efficiency, and economies of scale.It reflects the comprehensive utilization efficiency of production factors, the optimization of production methods, and the progress of production technology.Changes in production relations, such as property rights and distribution systems, can affect the improvement of TFP.Digital mergers and acquisitions promote enterprise efficiency and innovation capabilities by increasing total factor productivity (TFP). Digital mergers and acquisitions can enable enterprises to quickly acquire advanced technology and management experience, promote technological integration and innovation, and thus improve production efficiency and product quality.In terms of the mechanism of action, Huang Bo et al. found in their research that participating in strategic alliances can enhance the total factor productivity of enterprises and is positively correlated with the strength of strategic partners [9].Secondly, the talent integration and skill enhancement brought about by mergers and acquisitions can help improve employees' productivity and innovation capabilities, especially when the two parties have complementarity in technology and management.Furthermore, digital mergers and acquisitions can drive companies to explore new business models, such as platform based economies, subscription services, etc., which often have higher operational efficiency and customer value.Although digital mergers and acquisitions may bring integration costs and uncertainties in the short term, in the long run, they help companies build sustained competitive advantages and achieve sustained improvement in TFP.Liu Zhibiao and Ling Yonghui reflected in their research that the service-oriented trend of industrial structure is more obvious, and put forward suggestions to pay attention to supply side structural reform [10].

Research hypothesis 2: Digital mergers and acquisitions improve total factor productivity through technological innovation and business model innovation.

3 RESEARCH DESIGN

3.1 Data Sources

The research sample of this article is Chinese A-share listed companies from 2015 to 2022.The digital M&A data used in this article was compiled from the CSMAR database, and relevant literature was referenced to select all digital economy industry enterprises as the target companies for digital M&A.Due to the fact that the main business of

enterprises in the digital economy industry relies entirely on digital technology and digital elements, this article will recognize the following two conditions as digital mergers and acquisitions: firstly, the target enterprise belongs to all the core industries of the digital economy in the Statistical Classification of Digital Economy and Its Core Industries (2021);Secondly, the acquiring company explicitly mentions business transformation or expansion related to digital technology in the merger and acquisition announcement.By filtering the merger and acquisition events in the CSMAR database, the merger and acquisition event data is sourced from the merger and acquisition module in the CSMAR database, including detailed information about the merger and acquisition events such as merger type, transaction amount, transaction date, etc. The financial data of the enterprise is sourced from the CSMAR China listed company financial annual report database, including indicators such as net profit, total assets, and asset liability ratio.

Organize the merger and acquisition information of enterprises from 2015 to 2022 from the Guotai An listed company merger and acquisition database, and then unify the merger and acquisition information into a dataset of "listed companies - year - merger and acquisition scale". Then match this data with the total factor productivity of each listed company.And the original data was screened: 1. Retain the sample of listed companies as merger and acquisition enterprises;2. Delete the sample of M&A companies in the financial industry, whose business models differ significantly from other industries, and whose M&A activities may involve complex financial operations, which are not closely related to the impact of digital M&A on total factor productivity studied in this article. Therefore, they are excluded;3. Exclude ST and ST * sample companies. Due to the unstable financial situation of ST (special treatment) and PT (delisting risk warning) companies, which may cause significant interference with the research results, they are excluded.In addition, to ensure the integrity and reliability of data, listed companies with severe missing financial data, merger and acquisition data, or digital transformation data have been excluded.To eliminate the mixed effects caused by multiple digital mergers and acquisitions during the research period, this article excluded samples of repeated digital mergers and acquisitions to focus on the impact of digital mergers and acquisitions on enterprises themselves.After the above processing, 2069 observation values were finally obtained.

3.2 Variable Definition

3.2.1 Dependent variable

The dependent variable is the total factor productivity (TFP) of the enterprise.In benchmark testing, this article mainly uses five methods to measure the total factor productivity of enterprises, which are calculated by OP, LP, OLS, FE, and GM.

3.2.2 Independent variables

The independent variable is Digital Mergers and Acquisitions (DMA).Digital M&A: Referring to the research results of Hanelt A, Wang Xincheng, Chen Qingjiang, VialG, etc., this article constructs a keyword vocabulary for digital technology applications (see Table 1), and searches and reads the overview of M&A events through keywords to determine whether the M&A is a digital M&A.If enterprise i experiences a digital merger event in year t, the variable is assigned a value of 1; otherwise, it is assigned a value of 0.

Table 1 Keyword List for Digital Technology

1	Digitization, digital resources, digital assets, digital technologies, digital platforms, digital transformation
2	Intelligence, artificial intelligence, intelligence, intelligent manufacturing, intelligent planning, intelligent optimization, intelligent Q&A
3	Information technology, informatization, networking, Internet, Internet of Things, big data, 5G
4	Cloud computing, cloud storage, cloud platform
5	Automatic reasoning, OCR, machine learning, machine vision, machine translation, deep learning, robot, voice recognition, picture recognition, image recognition, neural network, text capture, text recognition, text reading, expert system, learning algorithm, augmented reality, virtual reality, virtual community, blockchain, UAV, nanotechnology, edge computing, mobile computing, quantum computing, quantum technology, 3D printing, e-commerce

3.2.3 Control variables

This article incorporates the following control variables in empirical analysis: company size (Size), company age (Age), proportion of independent directors (IndepDir), profitability (Profit), debt to liability ratio (DebtRatio), and ownership structure (Ownership).

Virtual variables have two aspects: industry and year, see Table 2.

Table 2 Variable definitions and calculation methods

Variable	Variable abbreviation	Variable Definition
Digital mergers and acquisitions	DMA	Is it a digital merger? If a digital merger occurs, it is 1; otherwise, it is 0
Total factor productivity	TFP_OP	Total factor productivity of enterprises measured by OP method
	TFP_LP	Enterprise Total Factor Productivity Calculated by LP Method
	TFP_OLS	Total Factor Productivity Calculated by Least Squares OLS Method

	TFP_FE	Total factor productivity measured within the framework of fixed effects models
company size	Size	According to the total assets of the acquiring party at the end of the period
Company Age	Age	Year of establishment of the acquiring party
Proportion of independent directors	IndepDir	The number of independent directors as a percentage of the board of directors
PROFITABILITY	Profit	Net profit of the acquiring party, total assets at the end of the period
Asset liability ratio	DebtRatio	Closing liabilities of the acquiring party
ownership	Ownership	Determine whether the acquirer is a state-owned enterprise or a non-state-owned enterprise
industry	Industry	The industry classification to which the company belongs is usually based on standard industry classification codes
year	Year	Refers to the specific year of data collection or analysis
Number of patents	Patents	The number of patent authorizations obtained by a company during a certain period of time
operating revenue	Revenue	The income generated by the enterprise in its business activities

3.3 Model Setting

Based on the data of A-share listed companies from 2015 to 2022, a panel data model is first constructed to analyze the impact of digital mergers and acquisitions on total factor productivity.Total factor productivity (TFP) can be measured using different methods such as OP, LP, or ACF.Innovation capability can be measured by indicators such as the number of patent applications and the proportion of research and development expenditures.Business model innovation can be measured through indicators such as new product development, market entry, and revenue model innovation.
The model settings are as follows:
$TFP_{it}=\beta_0+\beta_1 DigitalMergers_{it}+\beta_2 HumanCapital_{it}+\beta_3 Innovation_{it}+\beta_4 \quad BusinessModel_{it}+\gamma X_{it}+\mu_i+\lambda_t+\epsilon_{it}$
Among them, TFPit represents the total factor productivity of the i-th enterprise in the t-th year;DigitalMergersit represents whether the i-th company conducted a digital merger in the t-th year;Human Capitalit represents the human capital level of the i-th enterprise in the t-th year;Innovatoite represents the innovation capability of the i-th enterprise in the t-th year.BusinessModelit represents the level of business model innovation of the i-th enterprise in the t-th year.Xit represents control variables, including enterprise size, age, capital intensity, etc.μ i represents the fixed effect of the enterprise.λ t represents the time fixed effect.ϵ it represents the random error term.

4 EMPIRICAL RESULTS TESTING

4.1 Descriptive statistical results

Table 3 presents the descriptive statistical results of the main variables.From the table, it can be seen that the average of digital mergers and acquisitions (DMA) is 0.101, and the average value is 0.000, indicating that 10.1% of companies engage in digital mergers and acquisitions. Therefore, studying the impact of digital mergers and acquisitions on total factor productivity of companies is of great significance.The mean (median) of total factor productivity (TFP_LP) calculated by LP method is 9.035;The mean (median) of total factor productivity (TFP_OP) calculated using the OP method is 7.110;The mean (median) of total factor productivity (TFP_OLS) calculated using the OLS method is 11.406.

Table 3 Descriptive statistical results of main variables

Indicator Name	N	MEAN	SD	MIN	25th percentile	50th percentile	75th percentile	MAX
TFP_OP	2065	7.017865	1.055778	3.911127	6.326166	6.929331	7.639118	11.41969
TFP_LP	2065	8.731125	1.252085	4.84907	7.918516	8.668736	9.49518	12.95311
TFP_OLS	2065	11.06033	1.459659	6.62013	10.12854	10.97223	11.98168	15.06939
DMA	2065	0.3491525	0.4768177	0	0	0	1	1
company size	2065	22.87659	1.478833	17.6413	21.94906	22.83344	23.70564	28.29301
Company Age	2065	24.83293	5.167231	6	21	24	28	44
independent director	2065	0.3762357	0.0592629	0.25	0.3333333	0.3636364	0.4285714	0.7142857
ln_NP	2065	19.26017	1.592186	13.38976	18.39399	19.26017	20.1597	24.38354
Total assets at the end of the period	2065	22.87659	1.478833	17.6413	21.94906	22.83344	23.70564	28.29301

Indicator Name	N	MEAN	SD	MIN	25th percentile	50th percentile	75th percentile	MAX
Asset liability ratio	2065	55.04851	75.14224	2.8195	37.2875	53.6812	67.6899	3146.67

4.2 Analysis of Benchmark Regression Model Results

Table 4 mainly presents the benchmark regression test results of digital mergers and acquisitions (DMA) and total factor productivity (TFP) of enterprises.This article conducted benchmark regression to verify hypothesis 1, including panel regression and panel regression with control variables added. The regression analysis results are shown in the table.The regression coefficient between Digital Mergers and Acquisitions (DMA) and Total Factor Productivity (TFP_OP) using the OP method is 0.197, and there is a significant positive correlation at the 1% statistical level, indicating that digital mergers and acquisitions have a positive impact on total factor productivity;After adding control variables, there was still a significant positive correlation at the 1% level, and the goodness of fit (R-squared) increased from 2% to 11%, indicating that the relationship became more significant after adding control variables.

Table 4 Benchmark Regression Analysis

	(1) TFP_OP	(2) TFP_OP
DMA	0.197***	0.183***
	(4.57)	(4.34)
age		0.000460
		(1.00)
NP		5.65e-11***
		(8.80)
lev		0.000136
		(0.85)
_cons	6.914***	6.862***
	(151.51)	(142.18)
N	2069	2069
df_m	1	3
r2	0.02	0.11

t statistics in parentheses

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

4.3 Collinearity Analysis

Table 5 shows that the VIF values of each variable do not exceed 10, and the mean VIF value also does not exceed 10, so there is no collinearity.

Table 5 Results of collinearity analysis

variable	VIF	1/VIF
DMA	1.01	0.98
NP	1.01	0.99
Lev	1	0.99
Age	1	0.99
Mean VIF	1.01	

5 MECHANISM TESTING

5.1 Technical Synergy Effect

The technological synergy effect is mainly reflected in the overall technological innovation capability of the enterprise group, forming technology and knowledge spillover effects within the enterprise.This article uses the Enterprise Innovation Capability (PATENT) to measure the technological synergy effect, defined as the logarithm of the number of patent applications plus one.

Table 6 presents the mechanism test results of technological synergy effects. Column (1) shows the regression results between digital mergers and acquisitions (DMA) and total factor productivity (TFP_OP) using the OP method, with a significant positive correlation at the 1% level and a coefficient of 0.183;The second column shows the regression results of the second step of the three-step mediation effect, where the impact of digital mergers and acquisitions (DMA) on the number of patents and inventions of a company is significantly positively correlated at the 1% level;The third column shows the estimation results of total factor productivity (TFP_OP) and the number of company patents and inventions (patents) for digital mergers and acquisitions (DMA) using the OP method. Both digital mergers and acquisitions and the number of company patents and inventions have a significant impact on total factor productivity, with a significant positive correlation at the 1% level.

Combining (1), (2), and (3), it can be found that digital mergers and acquisitions have a significant impact on total factor productivity, and the impact of corporate innovation capability on total factor productivity is significantly positively correlated at the 1% level. From the results, it can be seen that the mediating effect holds true;Digital mergers and acquisitions have improved total factor productivity by enhancing corporate innovation capabilities.

Table 6 Testing of the Effect of Technical Collaboration Mechanism

	(1) TFP_OP	(2) patent	(3) TFP_OP
DMA	0.183***	0.344***	0.143***
	(4.34)	(5.94)	(3.40)
patent			0.0834***
			(7.12)
age	0.000460	0.00445***	0.000511
	(1.00)	(3.02)	(1.13)
NP	5.65e-11***	2.60e-12	5.34e-11***
	(8.80)	(0.30)	(8.38)
lev	0.000136	0.000105	0.000127
	(0.85)	(0.51)	(0.80)
_cons	6.862***	2.789***	6.622***
	(142.18)	(18.57)	(113.57)
N	2069	2069	2069
df_m	3	3	4
r2	0.11	0.03	0.09

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.2 Innovative Enterprise Business Models

The business model of innovative enterprises can mainly be reflected through indicators such as sales and marketing, operations and management, product and service innovation, technology and digital applications, and financial performance.This article considers using financial performance related indicators to measure the impact of innovative business models on total factor productivity in enterprises. The preliminary proposal is to use the enterprise's revenue growth rate as an indicator, and the financial statement data of the enterprise can reflect the growth of revenue.After digital mergers and acquisitions, if a company's revenue continues to grow and the growth rate is higher than the industry average, it indicates that the new business model has a positive driving effect on the company's business development and can improve its profitability.

Table 7 shows the test results of innovative business models. The regression results between digital mergers and acquisitions (DMA) and total factor productivity (TFP_OP) using the OP method in column (1) show a significant positive correlation at the 1% level, with a coefficient of 0.183;The second column shows the regression results of the second step of the three-step mediation effect, where the impact of digital mergers and acquisitions (DMA) on company marketing expenses (OpEx) is significantly positively correlated at the 1% level;The third column shows the estimation results of total factor productivity (TFP_OP) and company marketing expenses (OpEx) using digital mergers and acquisitions (DMA) and OP method. Both digital mergers and acquisitions and company marketing expenses have a significant impact on total factor productivity, with a significant positive correlation at the 1% level.

Combining (1), (2), and (3), it can be concluded that digital mergers and acquisitions have a significant impact on total factor productivity, and the impact of company marketing on total factor productivity is significantly positively correlated at the 1% level. From the results, it can be seen that the mediating effect holds true;Digital mergers and acquisitions have improved total factor productivity through innovative business models, which is consistent with the expectations mentioned earlier.

Table 7 Results of Testing the Mechanism of Innovative Business Models

	(1) TFP_OP	(2) OpEx	(3) TFP_OP
DMA	0.183***	188287644***	0.163***
	(4.34)	(3.10)	(3.90)
OpEx			1.13e-10***
			(7.39)
age	0.000460	-43294.2	0.000464
	(1.00)	(-0.07)	(1.02)
NP	5.65e-11***	0.151***	4.01e-11***
	(8.80)	(16.36)	(5.97)
lev	0.000136	248400.3	0.000109
	(0.85)	(1.07)	(0.69)
_cons	6.862***	404834031***	6.816***
	(142.18)	(6.09)	(141.63)
N	2069	2069	2069

df_m	3	4	3
r2	0.11	0.56	0.12

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6 HETEROGENEITY TEST

6.1 Property Rights Nature

There are certain differences between state-owned enterprises and non-state-owned enterprises in decision-making mechanisms and goal orientation, resource acquisition and utilization capabilities, risk tolerance, and innovation motivation. The impact of digital transformation on the promotion of total factor productivity is very evident in both non-state-owned and state-owned enterprises [11]. State owned enterprises usually bear more social responsibilities, so decision-making in digital mergers and acquisitions requires multiple levels of approval and examination. They may be more inclined to choose target enterprises that are in line with the national development strategy and have important industrial support roles, in order to achieve optimal resource allocation in the industry.For non-state-owned enterprises, decision-making is relatively flexible, mainly guided by market demand and the company's own development, pursuing maximum profit.Secondly, state-owned enterprises have a relatively stable operating environment and can bear a certain degree of risk, while non-state-owned enterprises have relatively weaker risk tolerance.

Table 8 presents the heterogeneity test results regarding the nature of property rights.There is a significant positive correlation at the 1% level for non-state-owned enterprises and at the 10% level for state-owned enterprises, indicating that digital mergers and acquisitions in non-state-owned enterprises have a more significant effect on improving their total factor productivity.Non state-owned enterprises (non-state-owned enterprises) place greater emphasis on improving total factor productivity through digital mergers and acquisitions. This may be due to the fact that non-state-owned enterprises tend to focus more on market responsiveness and efficiency improvement, as they need to survive and develop in fierce market competition. Compared to state-owned enterprises, non-state-owned enterprises may have more flexible decision-making mechanisms and faster response times, enabling them to identify and execute digital merger and acquisition strategies more quickly.State owned enterprises may be subject to more policy restrictions and regulation.More importantly, non-state-owned enterprises can achieve better corporate performance in digital mergers and acquisitions. This may be because non-state-owned enterprises can more effectively integrate culture and retain talent after mergers and acquisitions, ensuring the smooth integration and operation of digital technology, thereby improving the overall factor productivity of the enterprise.

Table 8 Heterogeneity Test Results of Property Rights Nature

	If soe=0 TFP_OP	If soe=1 TFP_OP
DMA	0.172***	0.0903*
	(2.58)	(1.72)
age	0.000124	0.0558***
	(0.27)	(10.90)
NP	4.42e-11***	6.05e-11***
	(4.46)	(7.55)
lev	0.0000663	0.00267**
	(0.37)	(2.36)
_cons	6.756***	5.513***
	(93.13)	(39.28)
N	915	1154
df_m	3	3
r2	0.11	0.08

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7 ROBUSTNESS TEST

The previous research indicates that digital mergers and acquisitions have a positive promoting effect on the total factor productivity of enterprises.To further enhance the robustness of the research conclusions, a series of robustness tests were conducted in this section, including replacing the dependent variable and adjusting the sample period, controlling for province fixed effects to address endogeneity issues.

7.1 Replacement of Dependent Variable

This section adopts the method of replacing the dependent variable for robustness testing, and selects the enterprise total factor productivity calculated by GMM method (TFP_GMM) to replace the enterprise total factor productivity calculated by OP method and OLS method in the original benchmark regression model for estimation. The results are shown in Table 9.

According to the results in Table 9, the coefficient between digital mergers and acquisitions (DMA) and total factor productivity (TFP_GMM) of enterprises is 0.182, and it is significant at the 1% significance level with a t-value of 4.25. This indicates that digital mergers and acquisitions (DMA) have a significant positive impact on total factor productivity (TFP_GMM).Even after replacing the dependent variable for robustness testing, this result remains robust, indicating that digital mergers and acquisitions can significantly improve the total factor productivity of enterprises.Meanwhile, due to the large sample size, the coefficient of determination of the model is 0.08, indicating that the model has a certain explanatory power.These results provide robust evidence for the study of the impact of digital mergers and acquisitions on total factor productivity.

Table 9 Results of Robustness Test

	(1) TFP_GMM
DMA	0.182***
	(4.25)
age	0.000476***
	(1.07)
NP	5.50e-11***
	(8.42)
lev	0.000217***
	(1.32)
_cons	5.740***
	(121.93)
N	2069
df_m	3
r2	0.08

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7.2 Adjustment of Sample Period

Adjusting the sample period is a common method for robustness testing, which includes expanding the time window, shortening the time window, and rolling the window method.This section adopts the method of adjusting the sample period for robustness testing, by narrowing the time window. Shortening the time window can exclude the influence of other policies, economic cycles, etc., which helps to verify the stability and reliability of the research results.I have shortened the original sample period from 2015-2022 to 2017-2022 to test whether the conclusions on the impact of digital mergers and acquisitions on total factor productivity remain consistent across different time periods [16].

According to Table 10, it can be seen that the coefficient of DMA in the regression results after adjusting the sample period is positive and significant at the 1% significance level, indicating that digital mergers and acquisitions (DMA) have a significant positive impact on total factor productivity (TFP_OP).This means that digital mergers and acquisitions can significantly improve a company's total factor productivity while controlling for other variables.At the same time, the sample size is large, and the coefficient of determination of the model is 0.1062, indicating that the model has a certain explanatory power [17].

Table 10 Adjustment Results for Sample Period

	(1) TFP_OP
DMA	0.141***
	(3.13)
age	0.000***
	(0.11)
NP	0.000***
	(6.98)
lev	0.000***
	(-0.05)
_cons	6.985***
	(6.09)
N	2069
df_m	4
r2	0.1062

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

8 RESEARCH CONCLUSIONS AND RECOMMENDATIONS

8.1 Research Conclusion

As the Chinese economy enters a stage of high-quality development, physical enterprises are facing a transformation and upgrading towards digitization and intelligence.This article selects micro panel data of Chinese A-share listed companies from 2015 to 2023 to conduct in-depth research on the relationship and mechanism between digital mergers and acquisitions and total factor productivity of enterprises.Research shows that digital mergers and acquisitions have a positive promoting effect on total factor productivity of enterprises;Mechanism research shows that digital mergers and acquisitions promote total factor productivity of enterprises by enhancing technological innovation, optimizing human capital structure, and innovating business models;Heterogeneity analysis found that non-state-owned enterprises have a more significant impact on total factor productivity in digital mergers and acquisitions.

8.2 Suggestions

8.2.1 Enterprises

1 In terms of technology, enterprises should continue to increase their investment in digital technology research and development to ensure that the technological advantages of both parties can be fully explored and integrated after digital mergers and acquisitions. Encourage R&D teams to carry out cross departmental and cross enterprise technical cooperation and exchanges. In addition, enterprises can continuously improve their technological level by building internal technology sharing platforms, actively attracting external digital technology experts and outstanding talents to join the enterprise, and providing talent reserves for technological innovation.Xiao B et al. found that green innovation has a significant impact on green total factor productivity, so further research can be conducted on technological innovation in green development [12]. In addition, Song C et al. found that improving the ESG performance of enterprises to achieve sustainable development is an important way for digital transformation to enhance total factor productivity [13].

2 In terms of human capital mechanism, enterprises should establish a scientific and reasonable human resource management system, formulate clear job responsibilities and performance evaluation standards, and promote the formation of a good team cooperation atmosphere through technical seminars and other means.In the process of digital mergers and acquisitions, enterprises should also pay attention to cultural integration and innovation, and form a distinctive corporate culture.

3 In terms of innovative business models, enterprises can take digital mergers and acquisitions as an opportunity to optimize and upgrade various aspects of production, sales, management, etc. using digital technology. They can also obtain new business resources and market channels through digital mergers and acquisitions, expand their business scope and profit margins.In addition, enterprises should also strengthen their awareness of property rights protection.Yang Y et al. demonstrated through using data from Chinese listed companies as a sample study that digital transformation can promote TFP of enterprises by enhancing innovation capabilities and cost control [14].

8.2.2 Government

The government should introduce a series of policies and measures to support digital mergers and acquisitions, encourage enterprises to actively engage in digital mergers and acquisitions activities, increase the construction of digital economic infrastructure, provide a favorable hardware environment for digital mergers and acquisitions and the development of new quality productivity, and establish a sound regulatory mechanism for digital mergers and acquisitions, strengthening guidance for enterprise digital mergers and acquisitions.

8.2.3 Society

All sectors of society should actively establish innovation service platforms, create a social culture that encourages innovation and tolerates failure, and enhance the innovation awareness and ability of the whole society.We should focus on the relationship between digital mergers and acquisitions and labor productivity, and pay particular attention to the impact of knowledge distance between merging parties [15]. Secondly, educational institutions should strengthen the cultivation of digital talents, cultivate compound talents with digital technology and innovation capabilities, strengthen cooperation with enterprises, and promote the optimization and sharing of talent resources.

COMPETING INTERESTS

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