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Analysis of the Influencing Factors of Digital Transformation on Enterprise Innovation and Development

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Abstract

Based on the data of Chinese listed companies from 2007 to 2022, this article deeply analyzes the catalytic effect of digital transformation on enterprise innovation and development. Research has found that digital transformation significantly promotes the improvement of enterprise innovation capabilities, and exhibits heterogeneity among different types of enterprises. After sufficient robustness testing, this conclusion still holds true; When financing constraints are high, the promotion effect of digital transformation on enterprise innovation is stronger, that is, digital transformation can effectively alleviate the financing constraints of enterprises and empower enterprise innovation; The level of human capital can positively regulate the promoting effect of digital transformation on the high-quality development of enterprises. This study not only enriches the theoretical framework of the relationship between digital transformation and enterprise innovation development, but also provides useful references and inspirations for enterprises to implement digital transformation and enhance innovation capabilities.

Keywords: digital transformation, technological innovation, high quality development

1. Introduction

Innovative development of enterprises is not only the key to enhancing their competitiveness, but also the necessary path to achieving sustainable development. Through innovation, enterprises can continuously introduce new products and services, optimize operational processes, improve production efficiency, and stand out in fierce market competition. The innovative development of enterprises is not only related to their survival and growth, but also of great significance in promoting the economic progress and industrial upgrading of the entire society.With the rapid development of information technology and the deep integration of the global economy, digital transformation has become an unavoidable issue for enterprises. Digital transformation, in short, refers to the use of digital technology by enterprises to reform their business models, organizational structures, and corporate culture to adapt to the increasingly changing market environment and customer needs. This transformation process not only involves technological updates and iterations, but also a profound revolution in management and thinking. In today's era of information explosion, enterprises are facing unprecedented challenges and opportunities. The challenge lies in the fact that traditional business models and management methods are no longer able to cope with the rapidly changing market environment; The opportunity lies in the fact that digital transformation provides enterprises with the possibility to break through bottlenecks and achieve innovative development. More and more companies are realizing that digital transformation is not only a necessary condition for their survival, but also a catalyst for their innovative development. The country attaches great importance to the top-level design of digital transformation, and formulates overall plans and strategic layouts at the national level to ensure the scientific, rational, and sustainable nature of digital transformation. The 14th Five Year Plan and 2035 Vision Goal Outline clearly proposes to accelerate the construction of a digital China and promote comprehensive changes in production, life, and governance through digital transformation.The scale of China's digital economy continues to grow rapidly. During the period from 2017 to 2021, the size of China's digital economy has achieved significant growth, rising from 27 trillion yuan to 45.5 trillion yuan. At the same time, its proportion in GDP has also increased to 39.8%. It is expected that by 2024, the scale of China's digital economy will reach 68.3 trillion yuan, demonstrating enormous development potential. Although it is widely recognized that digital transformation is of great significance for the innovation and development of enterprises, companies still encounter numerous difficulties and confusions in specific practical aspects. Can digital transformation truly become a powerful catalyst for driving enterprise innovation forward? How should enterprises cope with various challenges and ensure the success of digital transformation? Therefore, exploring whether digital transformation

can become a catalyst for enterprise innovation and development not only has theoretical significance, but also practical value.

2.Theoretical Analysis and Hypothesis Proposal

2.1 Digital Transformation and Enterprise Innovation

In the rapidly developing environment of information technology and digital technology, enterprises have embarked on the path of digital transformation. A comprehensive transformation to cope with market competition and changes in customer demand. This transformation is not only a technological update, but also a comprehensive adjustment of enterprise strategy, organizational structure, and operational mode (Xu Li, 2023). Through digital transformation, enterprises can utilize advanced technologies such as big data, cloud computing, and artificial intelligence to optimize business processes and innovate product services, thereby helping to enhance market competitiveness and promote the established goal of high-quality development. Looking back at numerous literature sources, it can be found that the impact of digital transformation on enterprise innovation can be analyzed in depth from two dimensions: the internal environment perspective of the enterprise and the external market perspective.

From an internal perspective, digital transformation has improved the operational efficiency and management level of enterprises by integrating and optimizing their internal business processes. This change not only enables enterprises to respond to market changes more quickly and accurately, but also promotes the formation of an innovative atmosphere within the enterprise (Qi Yudong and Xiao Xu, 2020). In addition, digital transformation has promoted the integration and utilization of enterprise data resources, providing strong data support for enterprise innovation (Li Qijia and Luo Fukai, 2024). At the same time, digital transformation has also promoted the sharing and exchange of knowledge within enterprises, stimulating employees' innovative vitality. The digital transformation has a significant impact on the improvement of innovation performance in manufacturing enterprises, which is partly attributed to the enhancement of internal dynamic capabilities (Zhang Jide and Yuan Miaomiao, 2024).

From an external perspective, digital transformation has changed the way businesses interact with the external environment, providing new opportunities and challenges for innovation. On the one hand, digital transformation enables enterprises to better understand market demand and competitive trends, thereby innovating products or services more targetedly. Enterprises can use big data analysis to predict market trends, guide the development of new products, and formulate marketing strategies (Yang Xinyue and Zhou Shaoni, 2024). On the other hand, digital transformation has also intensified market competition, forcing companies to constantly seek new innovation points to maintain their competitive advantage. The research by Zhu Changning and Li Hongwei (2024) shows that one of the mechanisms by which digital transformation affects the high-quality development of enterprises is through enhancing their innovation capabilities and market competitiveness.

Overall, whether viewed from an internal or external perspective, digital transformation has had a profound impact on enterprise innovation. By integrating internal resources, optimizing business processes, and strengthening interaction with the external environment, the innovation process of enterprises is strongly promoted through digital transformation. In view of this, this article proposes hypothesis 1.H1: Digital transformation of enterprises can significantly enhance their innovation capabilities.

2.2 Impact Mechanism of Digital Transformation on Enterprise Innovation

From the perspective of human capital, digital transformation enhances the skill level and innovation ability of enterprise employees by introducing advanced information technology and digital tools. Digital transformation requires employees to have higher digital literacy and data analysis capabilities, which prompts companies to increase investment in employee training and education, and improve their human capital level. On the one hand, digital transformation not only optimizes employees' workflow, but also stimulates their innovative potential, thereby promoting the improvement of enterprise innovation capabilities. On the other hand, the human capital structure of enterprises is one of the key factors affecting innovation. Digital transformation can enhance the innovation resilience of enterprises by optimizing their human capital structure (Wang Wenhua and Wang Wenqing, 2024). At the same time, the empowering effect of digital transformation on human capital property incentives can further stimulate employees' innovation motivation (Yuan Chen and Ma Lianfu, 2024). In view of this, this article proposes hypothesis 2.H2: Digital transformation of enterprises can promote innovative development by enhancing the level of human capital.

From the perspective of financing constraint theory, financing constraints are an important factor affecting corporate innovation. Digital transformation enables enterprises to more accurately grasp market demand and

customer preferences, thereby optimizing product design and production processes, and enhancing product market competitiveness. This improvement in competitiveness can enhance investors' confidence in the enterprise, thereby reducing the financing costs of the enterprise. In addition, digital transformation can also improve the operational efficiency and profitability of enterprises, enhance their debt paying ability, and further reduce financing costs. When enterprises face lower financing constraints, they are more capable of investing in research and innovation activities, thereby promoting technological innovation and product upgrading. In addition, digital transformation has further promoted innovation activities of enterprises by expanding their financing channels and reducing financing costs (Guo Lingli, 2023). Therefore, digital transformation of enterprises can help alleviate financing constraints and promote enterprise innovation (Zhao Hengbin, 2024) In view of this, this article proposes hypothesis 3.H3: Digital transformation of enterprises can promote innovative development by alleviating financing constraints.

3. Research Design

3.1 Data Sources

This study takes Chinese listed companies from 2007 to 2022 as the sample subjects. The data on the number of patent applications used to measure the innovation output of enterprises is taken from the CNRDS database, while the data reflecting the degree of digital transformation of enterprises and other related variables are sourced from the CSMAR database. To ensure data quality and research validity, the raw data will be processed according to the following criteria: (1) Given the unique business models and financial characteristics of listed companies in the financial industry, their samples will be excluded from the research scope; (2) Enterprises in special financial difficulties and marked as ST or * ST, due to their unstable operating conditions, are also excluded; (3) Samples with missing values for key variables are also discarded to ensure the accuracy and reliability of subsequent empirical analysis.

3.2 Variable Design

Explained variable: Enterprise innovation.The patent application showcases the company's investment achievements in innovative projects, which is also a criterion for evaluating the company's innovation strength.Against the backdrop of the increasing proportion of R&D expenditure to operating revenue in enterprises, studying the relationship between patent application volume and R&D expenditure is of great significance. At the same time, compared with the number of patent authorizations, the number of patent applications can more accurately reflect the actual output time of innovative achievements, thus revealing the level of innovation more truthfully. At present, there is relatively little research on the relationship between the number of invention patent applications and technological innovation in China, and most of them use traditional econometric models for regression analysis. Therefore, drawing on the experience of Li Chuntao and Zheng Mani, the number of patent applications is regarded as a representative variable of corporate innovation activities. The data of patents exhibits the characteristic of "right bias", therefore, the number of patent applications is increased by 1, and then the natural logarithm is selected.

Core explanatory variable: degree of digital transformation of enterprises. Regarding the degree of digital transformation of enterprises, Wu Fei et al. (2021) first used the frequency of vocabulary related to "digital transformation" in the annual reports of listed companies as a standard for evaluating the level of digital transformation of enterprises. In related research fields, some scholars hold the view that previous academic explorations mostly relied solely on the virtual variable of whether a company has carried out digital transformation, using it as a proxy variable to conduct research. However, this approach has obvious shortcomings in accurately evaluating the effectiveness of a company's digital transformation. It should be noted that the annual report of a company is not just a summary and guiding material for external disclosure. It is also the core way for companies to transmit key information to various information users outside. So, when companies are fully committed to the wave of digital transformation, their determination to promote digital transformation and the phased results achieved are likely to leave a mark in their annual reports. In view of this, selecting the frequency of vocabulary related to "enterprise digital transformation" in the annual report as a measure of the depth of digital transformation is fully reasonable.

Control variables: Referring to previous research, the selection of control variables mainly includes the following aspects, including enterprise size (Employee), establishment period (FirmAge), asset liability ratio (Lev), fixed asset ratio (FIXD), capital intensity (CAP), and top five shareholder shareholding ratio (Top5).

Mediating variables: using the level of human capital and financing constraints of the enterprise as mediating variables. Among them, the level of human capital of enterprises is measured by the proportion of overseas experienced personnel.

Table 1. Descriptive Statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
lnInnovation	42,351	2.508	1.785	0	9.610
lnDTA	42,351	1.308	1.410	0	6.380
Lev	42,350	0.451	1.486	-0.195	178.3
FIXED	42,346	0.215	0.165	0	0.971
CAP	42,187	5.955	538.1	-19.92	110,126
Top5	42,351	53.74	15.67	0.811	99.23
FirmAge	42,351	2.859	0.378	0	4.174
Employee	42,298	7.601	1.319	0	13.25

3.3 Model Design

To study the impact of digital transformation on the innovation and development of enterprises, the following model is constructed:

$$\text{Innovation}_{i,t+1}=\alpha_{0+}\alpha_1 DTA_{i,t}+\sum_{i=2}^{12}\alpha_1\, Controls_{i,t}+\mu_t+\lambda_i+\varepsilon_{i,t} \quad (1)$$

Among them, $\text{Innovation}_{i,t+1}$ represents the innovation capability of the enterprise, $\text{DTA}_{i,t}$ represents the degree of digital transformation of the enterprise, $\text{Controls}_{i,t}$ includes the control variables mentioned above, represents the μ_t fixed effect of the year, λ_i represents the fixed effect of the enterprise, and ε is the random error term.The main coefficients that this article focuses on areα_1. If hypothesis 1 holds, that is, digital transformation of enterprises has a significant promoting effect on innovation, then it α_1 should be significantly positive.

To ensure the high robustness of research results, a series of rigorous measures have been taken. Firstly, considering that digital transformation has a certain time lag effect from initiation to substantial impact on enterprise innovation, and there is a high possibility of reverse causal correlation interfering with the accuracy of results, the natural logarithm of the number of patent applications for the next period of the enterprise plus one is selected as the dependent variable; Secondly, considering that continuous variables are susceptible to extreme value interference, in order to effectively avoid this problem, tail reduction operations are uniformly applied to all continuous variables at the 1% and 99% percentiles; Thirdly, in the process of constructing all regression models, both year fixed effects and firm fixed effects are simultaneously included, taking into account the differentiated effects of different years and individual firms from all aspects. Cluster adjustments are specifically carried out at the firm level to minimize errors caused by model settings, data characteristics, and other factors, ensuring that research results are authentic, reliable, and can withstand scrutiny.

4. Empirical Analysis

4.1 Benchmark Regression Results

Table 2 presents the regression analysis results on the impact of digital transformation on enterprise innovation and development. The ordinary OLS regression method without adding control variables and various fixed effects was used in column (1). The study found a significant correlation between the degree of digital transformation of enterprises and their innovative development, with a positive coefficient at the 1% significance level. This means that digital transformation of enterprises has a positive and significant driving effect on their innovative development. Column (2) shows the regression situation without introducing control variables, but with fixed effects added. From this result, it can be seen that the corresponding coefficients are also positive and can still maintain a significant state at the 1% significance level. As for column (3), this is a regression result that includes a series of control variables and fixed effects. It can be seen that the regression coefficient of the core explanatory variable, namely the degree of digital transformation, is still significantly positive at the 1% significance level. This result fully demonstrates that digital transformation can indeed significantly enhance the innovation capability of enterprises, which means that hypothesis 1 in the study is valid.

Table 2. Benchmark Regression Results

VARIABLES	(1) lnInnovation	(2) lnInnovation	(3) lnInnovation
lnDTA	0.270***	0.075***	0.034***
	(44.93)	(6.67)	(3.27)
Employee			0.395***
			(18.70)
Lev			0.005
			(0.75)
FIXED			-0.184*
			(-1.76)
CAP			0.000***
			(3.07)
Top5			0.001
			(1.19)
FirmAge			0.312***
			(3.00)
Constant	2.155***	0.912***	-2.640***
	(186.49)	(26.33)	(-9.18)
Industry FE	NO	YES	YES
Year FE	NO	YES	YES
Observations	42,351	42,351	42,129
R-squared	0.045	0.322	0.363

Note: * * * p<0.01, * * p<0.05, * p<0.10; The value of t in parentheses is the same as in the table below.

4.2 Mediation Effect Regression Results

The above test results confirm that digital transformation can promote innovative development of enterprises. Based on the previous theoretical analysis, a mediation effect model was constructed and tested using the method proposed by Wen Zhonglin et al. (2014). The testing steps are as follows: (1) Use lnInnovation as the dependent variable and lnDTA as the explanatory variable for regression analysis. (2) Regression analysis will be conducted using the mediating variable 'Overseas Back' as the dependent variable and 'lnDTA' as the explanatory variable. (3) Incorporate the digital transformation of enterprises (lnDTA) and the mediating variable of the proportion of overseas experience (Overseas Back) into the regression model to observe their impact on the innovation and development of enterprises. If the coefficient of the mediator variable is significant, it can be directly judged that hypotheses 2 and 3 proposed in the previous text are valid.

$$M_{it}=\beta_{0+}\beta_1 DTA_{i,t}+\sum_{i=2}^{12}\alpha_1\, Controls_{i,t}+\mu_t+\lambda_i+\varepsilon_{i,t} \quad (2)$$

$$\text{Innovation}_{i,t+1}=\alpha_2+\alpha_3 DTA_{i,t}+\alpha_4 M_{it}+\sum_{i=2}^{12}\alpha_3\, Controls_{i,t}+\mu_t+\lambda_i+\varepsilon_{i,t} \quad (3)$$

The regression results of the enterprise human capital level (Overseas Back) as a mediating variable are shown in columns (1) to (3) of Table 3

As shown. According to the regression results of column (1), the regression coefficient corresponding to enterprise digital transformation reaches 0.077 and passes the test at a significance level of 1%. This clearly indicates that enterprise digital transformation has a significant promoting effect on enterprise innovation and development. The regression results of column (2) show that the regression coefficient of enterprise digital transformation on the level of enterprise human capital is 0.022, which is also significant at the 1% significance level. This phenomenon strongly reveals that enterprise digital transformation promotes the improvement of enterprise human capital level. Furthermore, column (3) incorporates both enterprise digital transformation and human capital level into the regression model for analysis, and the regression coefficient for enterprise digital transformation becomes 0.072, which remains significant at the 1% level. Compared to 0.077 in column (1), the estimated coefficient in column (3) has decreased, but remains significant. At the same time, the regression coefficient of the human capital level of enterprises continues to be significantly positive. Based on these results, it can be concluded that the mediating effect of human capital level in enterprises does exist. In other words, digital transformation of enterprises first helps to increase the level of human capital, and then uses this as a path to promote innovative development of enterprises. Thus, hypothesis 2 has been successfully verified.

Table 3. Impact of Human Capital

	Human capital effect		
	(1)	(2)	(3)
VARIABLES	lnInnovation	OverseaBack	lnInnovation
lnDTA	0.077***	0.022***	0.072***
	(12.04)	(7.73)	(11.24)
OverseaBack			0.247***
			(21.62)
Constant	-5.792***	0.333***	-5.874***
	(-63.23)	(8.07)	(-64.47)
Observations	42,129	42,129	42,129
R-squared	0.310	0.012	0.319
Number of id	4,829	4,829	4,829
Control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES

Note: * * * p<0.01, * * p<0.05, * p<0.10; The value of t in parentheses is the same as in the table below.

When financing constraint (KZ) is used as an intermediary variable, the corresponding regression results are presented in columns (1) to (3) of Table 4. The results of column (1) show that the regression coefficient of enterprise digital transformation is 0.077, and it is significantly positive at the 1% significance level, which fully reflects the positive promoting effect of enterprise digital transformation on innovation and development. The results of column (2) show that the regression coefficient of enterprise digital transformation is -0.011, and it is significantly negative at the 5% significance level, indicating that enterprises can alleviate financing constraints by implementing digital transformation. The results in column (3) show that the estimated coefficient of KZ is significantly negative, while the regression results of enterprise digital transformation are significantly positive. This indicates that enterprise digital transformation can promote innovative development by alleviating financing constraints, thus verifying hypothesis 3.

Table 4. Impact of Financing Constraints

	Financing constraint effect		
	(1)	(2)	(3)
VARIABLES	lnInnovation	lnKZ	lnInnovation
lnDTA	0.077***	-0.011**	0.077***
	(12.04)	(-1.96)	(10.87)
lnKZ			-0.049***
			(-6.53)
Constant	-5.792***	1.066***	-5.920***
	(-63.23)	(13.97)	(-58.60)
Observations	42,129	35,404	35,404
R-squared	0.310	0.045	0.313
Number of id	4,829	4,412	4,412
Control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES

Note: * * * p<0.01, * * p<0.05, * p<0.10; The value of t in parentheses is the same as in the table below.

4.3 Robustness Test

(1) Replace the Explained Variable

The total number of utility model patent applications (lnInnovation_new) can to some extent reflect the changes in digital transformation. By substituting it as a substitute variable for the dependent variable in the regression equation, it can be seen from the regression results given in column (1) of Table 5 that the coefficient of the core explanatory variable (lnDTA) is significantly positive at the 1% level. This means that digital transformation of enterprises has indeed promoted innovative development, and the regression results still meet the expectations of the null hypothesis, once again verifying the correctness of the null hypothesis.

(2) Replace Core Explanatory Variables

The explanatory variable used in this article is the replacement of digital word frequency (lnDTA_B) to represent digital transformation. By substituting it as a substitute variable for the degree of digital transformation into the regression equation, the regression results shown in column (2) of Table 5 indicate that the coefficient of the core explanatory variable (lnDTA) is at the 1% level and shows a significant positive state, thus supporting the null hypothesis.

(3) Tail Reduction Processing

To eliminate the interference caused by outliers and non randomness in the data, this paper truncated the continuous variables of the benchmark regression sample by 0% -1% and 99% -100%, and performed regression analysis again. The corresponding regression results are shown in column (3) of Table 5. Among them, the coefficient of the core explanatory variable (lnDTA) shows a significant positive performance at the 1% level. The regression results still support the null hypothesis.

Table 5. Robustness Test

VARIABLES	(1) lnInnovation_new	(2) lnInnovation	(3) lnInnovation
lnDTA	0.031***		0.070***
	(3.00)		(6.27)
lnDTA_B		0.150***	
		(11.31)	
Constant	0.558***	0.654***	0.918***
	(17.56)	(15.29)	(26.62)
Observations	42,351	42,351	42,351
R-squared	0.280	0.327	0.318
Number of id	4,888	4,888	4,888
Control	YES	YES	YES
Industry FE	YES	YES	YES
Year FE	YES	YES	YES

Note: * * * p<0.01, * * p<0.05, * p<0.10; The value of t in parentheses is the same as in the table below.

4.4 Endogenous Test

(1) Explanatory Variable Lags Behind by One Period

Given the causal relationship between digital transformation and continuous innovation in enterprises, this relationship may interfere with the regression results. To eliminate this impact as much as possible, the lagged digital transformation (L.lnDTA) was selected as the explanatory variable for the correlation analysis. The specific results are shown in column (1) of Table 6.

(2) Heckman Two-Stage Analysis Method

Considering that the issue of sample self selection may have an impact on the research results, the Heckman two-stage analysis method is adopted to address it. Firstly, construct a Probit model based on whether the enterprise is

undergoing digital transformation (lnDTA dum), and use this model to examine the correlation between various factors and the enterprise's digital transformation, as shown in model (2):

$$\ln DTA_{it} = \beta_0 + \beta_1 East + \beta_2 Controls_{it} + \mu_{it} \quad (2)$$

In Model (2), an instrumental variable was added, following the approach of Liu Yanxia, to select whether it is an Eastern enterprise (East) as the instrumental variable. The inverse Mills ratio (imr) obtained from model (2) regression is used as the control variable to perform regression operations, with the aim of correcting the impact of self selection bias. According to columns (2) and (3) of Table 6, after addressing endogeneity issues, there is still a significant positive correlation between digital transformation and continuous innovation of enterprises, further verifying the close relationship between the two.

Table 6. Endogenous test

	(1)	(2) Phase One	(3) Phase 2
VARIABLES	lnInnovation	lnDTA-dum	lnInnovation
L.lnDTA	0.060***		
	(8.87)		0.160***
lnDTA			(24.13)
East		0.282***	
		(5.15)	
imr			0.060***
			(4.26)
Constant	-5.842***	-4.931***	-2.241***
	(-56.96)	(-61.23)	(-38.44)
Observations	37,216	42,118	29,557
R-squared	0.274	0.338	0.247
Number of id	4,385	4,824	4,824
Control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES

Note: * * * p<0.01, * * p<0.05, * p<0.10; The value of t in parentheses is the same as in the table below.

4.5 Heterogeneity Analysis

(1) Regional Heterogeneity

Due to significant differences in economic development, market size, policy systems, and overall level of digital economy development in different regions of China. Therefore, according to the location of the enterprise, it is divided into eastern enterprises, central enterprises, and western enterprises in China, and further examined the impact of the degree of digital transformation in different regions on the innovation and development of enterprises. The results are shown in Table 7, where columns (1), (2), and (3) respectively present the regression results of enterprises in the eastern, central, and western regions. From the obtained results, it can be seen that in terms of digital transformation, the regression coefficient of the eastern region is positive at a significance level of 1%, while the regression coefficients of the central and western regions are both positive at a significance level of 5%, with the central region having a larger coefficient. The reason why the central region has performed outstandingly in digital transformation is due to its active actions and significant achievements in the construction of free trade zones, the development of digital economy, and the process of new industrialization. These factors have jointly promoted the rapid development of digital transformation in the central region, making its degree slightly higher than that in the eastern and western regions.

Table 7. Regional Heterogeneity

VARIABLES	(1) East	(2) Mid	(3) West
lnDTA	0.076***	0.079**	0.063**
	(6.07)	(2.39)	(1.97)
Control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	29,726	5,764	6,848
R-squared	0.312	0.324	0.351

Note: * * * p<0.01, * * p<0.05, * p<0.10; The value of t in parentheses is the same as in the table below.

(2) Heterogeneity of Ownership

There are differences in policy support and subsidies enjoyed by enterprises of different ownerships in technology applications such as digital transformation. In view of this, based on the nature of enterprise ownership, enterprises are divided into two categories: state-owned enterprises and non-state-owned enterprises, and then grouped for regression analysis. The corresponding results are shown in Table 8, where column (1) presents the regression results for state-owned enterprises, while column (2) presents the regression results for non-state-owned enterprises. By observing and analyzing the results of columns (1) and (2), it can be found that in the sample of state-owned enterprises, when the regression coefficient of the degree of digital transformation is at a significant level of 1%, it shows a significant positive state; Similarly, in the non-state-owned enterprise sample, the regression coefficient of the degree of digital transformation is also significantly positive at the 1% significance level. This fully demonstrates that there is a positive correlation between the degree of digital transformation and the innovation and development of both state-owned and non-state-owned enterprises. And its promoting effect is stronger in non-state-owned enterprises than in state-owned enterprises. The reason may lie in the fact that non-state-owned enterprises, in the process of digital transformation, lack the rights granted by the state and the national will to undertake, and their core goals are more focused on legally achieving profit growth. This market-oriented transformation strategy enables non-state-owned enterprises to adjust and optimize their application of intelligent equipment and information technology more flexibly according to market demand, thereby quickly responding to market changes, improving efficiency and competitiveness. In contrast, as a manifestation of the national will, the digital transformation of state-owned enterprises not only needs to consider economic benefits, but also implement the policies of the Party and the state, carry out overall deployment, and meet the requirements of the country's future management of state-owned enterprises, which leads to non-state-owned enterprises being more effective in innovation and development than state-owned enterprises.

Table 8. Heterogeneity of Ownership

VARIABLES	(1) state-owned	(2) Non-state-owned
lnDTA	0.061***	0.082***
	(3.23)	(6.19)
Control	YES	YES
Firm FE	YES	YES
Year FE	YES	YES
Observations	15,668	25,613
R-squared	0.389	0.269

Note: * * * p<0.01, * * p<0.05, * p<0.10; The value of t in parentheses is the same as in the table below.

5. Research Conclusions and Recommendations

This article selects data from Chinese listed companies between 2022 as the research basis, and uses empirical analysis methods to examine the impact and mechanism of digital transformation on enterprise innovation and

development. The research has drawn the following conclusions: firstly, digital transformation of enterprises has a significant effect on enhancing their innovation capabilities, and this conclusion still holds true after a series of sufficient and rigorous robustness tests. Secondly, digital transformation of enterprises can promote the improvement of human capital level, thereby playing a promoting role in the innovation and development of enterprises. Thirdly, digital transformation of enterprises can also help promote innovative development by alleviating the financing constraints they face.

Based on the above research conclusions, the following policy implications can be obtained: firstly, the government should strengthen guidance and support for the digital transformation of enterprises, clarify the strategic position of digital transformation, and incorporate it into the national development strategic planning. Secondly, the government should increase investment in digital transformation, including financial support and tax incentives, to reduce the cost of digital transformation for enterprises. Thirdly, the government should strengthen the information security supervision of enterprises' digital transformation, establish a sound information security system and technical prevention measures.

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