Digital Innovation Awareness, Innovation Investment and Enterprise Digital Transformation

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Abstract. The digital innovation consciousness of top executives plays a key role in guiding companies' digital transformation strategy. This consciousness is likely to impact the company's investment in innovation and the success of its digital transformation. This research empirically explores the link between awareness of digital innovation, investment in innovation and business digitalization, using a sample of listed A shares from 2007 to 2022, a total of 33,536 samples. The research employs fixed-effects and mediation-effect models to analyze the mechanism of this relationship. The results show that awareness of digital innovation has a considerable contribution to the digital transformation of companies. Innovation investment plays the role of mediator between digital innovation consciousness and digital transformation of companies. The impact of awareness of digital innovation and innovation investment on digital transformation of businesses is more significant in the Northeast and Eastern regions than in other regions. Companies with a high market value have stronger digital innovation consciousness. High-tech industry enterprises have stronger digital innovation consciousness, and large-scale enterprises have a greater impact on digital transformation than small businesses. Executives with overseas experience have more influence on digital transformation than those without.

Keywords: Digital innovation consciousness; Innovation investment; Enterprise digital transformation

1 Introduction

Since the first proposal of the "National Big Data Strategy" in 2015, the government has successively introduced supportive policies to drive the digital transformation of businesses, further driving the optimization and upgrading the structure of industry and contributing to the revolutionary development of the digital economy. According to the "China Digital Economy Development Report (2023)", by the end of 2022, the scale of China's digital economy will have reached 50.2 trillion yuan, a nominal increase of 10.3% from the previous year, accounting for 41.5% of GDP. The digitalization of industries fluctuated around 82% of the digital economy, and the scale of China's digital industrialization has reached 9.2 trillion yuan, accounting for 18.3% of the digital economy. It is clear that the digital economy has become one of the important drivers of China's economic development, and the new development momentum triggered by technological innovation and digital transformation is an essential

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pathway to support the quality development of the digital economy, optimize and upgrade the industrial structure, and accelerate the construction of China's new development pattern. However, with the advancement of favorable policies and the rapid development of native digital enterprises, many traditional enterprises are facing tremendous transformation pressure. These enterprises may be reluctant or afraid to transform due to lack of funds, financing difficulties, weak technological innovation capabilities, and lagging transformation results. Currently, research into the factors that influence digital transformation in companies has become an important topic in both academia and practice, and different scholars have different views. Some scholars believe that IT and management commitment are key factors influencing the success of digital transformation in businesses, and management commitment has a greater impact on corporate digital transformation[1]. But some scholars believe that the digital element of products or services is conveyed through digital IT capabilities[3]. Other scholars believe that state benefits and taxation initiatives have a beneficial influence on companies' digital transformation, and research has also found that non-state companies with high levels of technology and strong absorption capacities have a greater level of digital processing [2]. From the existing research, it can be seen that enterprise digital transformation cannot be separated from the support of funds, policies, technology, and even more from the drive of management. The enterprise management plays an extremely important role in promoting the implementation of the digital transformation strategy, so whether the enterprise management has digital innovation consciousness has a significant impact on business innovation, which in turn affects the digital process of the enterprise. In view of this, based on theoretical analysis, this article uses panel data of companies listed on the A-share market from 2007 to 2022 and adopts fixed effect models and mediation-effect models, and empirically studies the impact of digital innovation consciousness on enterprise digital transformation and the mechanism effect of innovation investment between the two. The potential contributions of this document are as follows: First, it further enriches the influencing factors of enterprise digital transformation and provides empirical evidence; second, it provides a decision-making basis for formulating corporate digital transformation strategies.

2 Theoretical Analysis and Research Hypotheses

2.1 Digital innovation consciousness and enterprise digital transformation

According to innovation management theory[4] and upper echelons theory[5], the cognition and values of decision-makers will affect the organizational decision-making of enterprises. When managers make strategic decisions, they often propose them based on their profession, expertise, experience gained from their own experiences, and understanding of the company's development goals and vision under the external environment in which the company is currently located. The important role of executive cognition in corporate strategic decision-making. Executive cognition has a significant impact on corporate competitive dynamics[6]. Corporate executives can make cognitive contributions to strategic decision-making by completing cognitive tasks[7]. The cognition of corporate managers has a significant impact on environmental performance[8]. Cognitive CEOs can accelerate the enhancement of corporate value and stimulate corporate social responsibility activities[9]. The cognitive and ideological diversity of the executive team will affect business model

innovation[10]. The values, personality, experience, and educational background of the top management team will affect the strategic decisions and outcomes of executives[11].

According to related theories and research by scholars, it can be found that the cognitive awareness of corporate executives can affect the strategic decisions, business model innovation, social responsibility, environmental performance, etc. of the enterprise. Therefore, the consciousness of corporate executives has an important guiding role in corporate activities. It can be speculated that the stronger the digital innovation consciousness of corporate executives, the more conducive it is to the implementation of corporate innovation investment and digital transformation. Therefore, this paper proposes the following hypothesis:

H1: Digital innovation consciousness will have a favourable influence on companies' digital transformation.

2.2 Innovation investment and enterprise digital transformation

Investment in innovation is an important support and driving force for the success of companies' digital transformation. The results of empirical research show that R&D capabilities play a mediator function in the digital transformation process to improve business innovation performance[12].Some scholars believe that digital transformation can enable companies to achieve green development and reduce costs through green technological innovation, thereby reducing the incremental costs generated during the digital transformation process[13]. It can be found that innovation investment plays a conduction role in the process of successful digital transformation of enterprises. Generally speaking, the digital innovation consciousness of executives reflects the comprehensive understanding of the top management of the enterprise about innovation activities, which may have a considerable effect on the innovation investment and innovation results of the enterprise. The innovation investment of the enterprise can bring more growth and business opportunities, attract more investors, and promote the company's digital transformation. Therefore, the following hypotheses are put forward:

H2: Innovation investment has a more favorable impact on enterprise digital transformation.

H3: There is a conduction mechanism between innovation investment and the digital innovation consciousness and companies' digital transformation.

3 Research Design and Model Construction

3.1 Sample Selection and Data Source

This study selects companies listed in A shares from 2007 to 2022 as the research sample, excluding companies that have been treated as ST (Special Treatment, indicating financial or operational issues) and those with severe missing data. Using Stata 17 for balanced panel data processing, a total of 2096 listed companies with 33536 data points were obtained to form a balanced panel sample. The data for this study comes from the CSMAR database. Additionally, the Winsorize method is employed to tail-trim the data to eliminate the influence of outliers, and missing data are imputed using interpolation.

3.2 Variable Selection

3.2.1 Dependent Variable: Enterprise Digital Transformation (DT).

This paper constructs an enterprise digitalization index by counting the frequency of keywords such as artificial intelligence, blockchain, cloud computing, big data, and digital technology application, and then summarizing these frequencies.

3.2.2 Independent Variable: Digital Innovation Consciousness (Inno).

Drawing on the method of Huang Shanshan et al[14]. and making improvements, this paper uses the proportion of digital keyword counts in the Management Discussion and Analysis section of the annual report to the total word count of that section, and calculates its proportion to the total word count of the board report to represent the innovation consciousness of executives.

3.2.3 Mediating Variable: Innovation Investment (RD).

Following previous scholarly research, R&D investment is used as a measure of innovation investment.

3.2.4 Moderating Variables: Executive Overseas Background (Oversea), High-Tech Attribute (HT).

Following the method of Jin Xiaoshu[15], a dummy variable for executive overseas background is created, denoted as Oversea, assigning a value of 1 to executives on the board of directors and general managers with overseas experience, and 0 otherwise. High-tech enterprises are divided into three categories and nineteen major classes, with HT assigned a value of 1. The three categories are manufacturing (C), information transmission, software and information technology services (I) and scientific research and technical services (M); the nineteen main classes include C25, C26, C27, C28, C29, C31, C32, C34, C35, C36, C37, C38, C39, C40, C41, I63, I64 and M73; non-high-tech companies are those that do not fit these attributes, with HT receiving a value of 0.

3.2.5 Control Variables.

To eliminate potential endogeneity issues from omitted variables, this paper controls for other variables that may affect enterprise digital transformation. The paper selects Return on Assets (ROA), Total Asset Turnover (Tato), Enterprise Size (Size), Asset-Liability Ratio (Lev), Revenue Growth Rate (Growth), Board Size (Board), Ownership Concentration (Top1), Proportion of Independent Directors (Indep), and Institutional Investor Shareholding Ratio (Ins) as control variables and introduces annual and industry dummy variables. The specific variable descriptions are shown in Table 1.

Table 1. Main variable definition.

Categories	Variable name	Variable Symbol	Main Variable Description
Explained variable	Enterprise digital transformation	DT	The sum of the above five major word frequency indicators

Core Explanatory Variable	Digital Innovation Consciousness	Inno	The total number of words for keywords reflecting the executive's sense of digital innovation/the total number of words in the Board of Directors' Report section of the annual report, the total number of years in which the keywords were digitised in the Management Discussion and Analysis (MD&A) section, and the types of digitised keywords appearing in each year of the MD&A section are aggregated to take the natural logarithm.
Mediator variable	Innovation inputs	RD	R&D investment as a percentage of operating revenue
Adjustment variables	Overseas experience of executives	Oversea	Overseas experience = 1, no overseas experience = 0.
		Oversea_ratio	Average percentage of overseas experience
	High-tech properties	HT	High-tech firms = 1, non-high-tech firms = 0.
Control variables	Profitability	ROA	Net profit/total asset
	Operating capacity	Tato	Operating income/total assets total
	Corporate scale	Size	Lntotal assets
	Operating capacity	Tato	Operating income/total assets total
	Debt repayment	Lev	Total debt/total asset
	Development ability	Growth	Revenue growth rate
	Institutional investor holding shares	Ins	Institutional investor holding ratio
	Board size	Board	Number of boards plus 1 to take nature
	Independent director ratio	Indep	The total number of independent directors /board
	Equity concentration	Top1	The largest shareholder shareholding ratio
	Year	Year	Virtual variables of the year
	Industry	Industry	CSI industry classification in 2012

3.3 Model Construction

3.3.1 Fixed Effects Model.

To examine the direct impact of digital innovation consciousness on enterprise digital transformation, this study constructs the following econometric model based on the panel data of A-share listed companies from 2007 to 2022:

$$DT_{i,t} = \alpha_0 + \alpha_1 Inno_{i,t} + \sum Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (1)$$

In Equation (1), DT represents enterprise digital transformation, Inno represents digital innovation consciousness, Control represents control variables, Year and Industry represent year and industry dummy variables, respectively, and “i,t” is the random error term. Based on

Hypothesis 1, digital innovation consciousness is expected to have a favorable effect on the company's digital transition, with the expected regression coefficient $\alpha_1 > 0$.

3.3.2 Mediation Mechanism Test Model.

To further explore the mechanism by which digital innovation consciousness affects enterprise digital transformation, this study uses a mechanism analysis method to verify the existence of a pathway mechanism, building the following model on the basis of Model (1):

$$\text{Mediator}_{i,t} = \beta_0 + \beta_1 \text{Inno}_{i,t} + \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (2)$$

$$\text{DT}_{i,t} = \delta_0 + \delta_1 \text{Inno}_{i,t} + \delta_2 \text{Mediator}_{i,t} + \delta_3 \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (3)$$

Equation (3) is the combined expression for the regression of digital innovation consciousness on the mediating variable. Here, Mediator represents the innovation investment mechanism variable. The rest of the variables, including core explanatory and dependent variables, control variables, and year and industry fixed effects, are the same as in Equation (1).

3.3.3 Moderating Mechanism Test Model.

To verify whether the moderating variables, executive overseas background and high-tech attributes, affect enterprise digital transformation by moderating the relationship between executive innovation consciousness and innovation investment, this study builds the following model based on Model (1):

$$\text{DT}_{i,t} = \gamma_0 + \gamma_1 \text{Inno}_{i,t} + \gamma_2 \text{Oversea}_{i,t} + \gamma_3 \text{Inno\_Oversea}_{i,t} + \gamma_4 \text{RD}_{i,t} + \gamma_5 \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (4)$$

$$\text{DT}_{i,t} = \theta_0 + \theta_1 \text{Inno}_{i,t} + \theta_2 \text{HT}_{i,t} + \theta_3 \text{Inno\_HT}_{i,t} + \theta_4 \text{RD}_{i,t} + \theta_5 \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (5)$$

Here, i and t represent the enterprise and the year, respectively; Oversea represents the overseas background, and HT represents the high-tech attribute.

3.3.4 Long-Term Sustained Effect Test Model.

To verify the long-term sustained impact of digital innovation consciousness on enterprises, this study constructs a long-term sustained effect model based on Model (1). The specific formulation of this model would typically involve lagged variables or other methods to capture the long-term effects.

$$\text{DT}_{i,t} = \mu_0 + \mu_1 \text{Inno}_{i,t} + \mu_2 \text{L.Inno}_{i,t} + \mu_3 \text{RD}_{i,t} + \mu_4 \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (6)$$

$$\text{DT}_{i,t} = \varphi_0 + \varphi_1 \text{Inno}_{i,t} + \varphi_2 \text{L2.Inno}_{i,t} + \varphi_3 \text{RD}_{i,t} + \varphi_4 \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (7)$$

$$\text{DT}_{i,t} = \omega_0 + \omega_1 \text{Inno}_{i,t} + \omega_2 \text{L3.Inno}_{i,t} + \omega_3 \text{RD}_{i,t} + \omega_4 \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (8)$$

4 Empirical Results and Analysis

4.1 Descriptive Statistics and Correlation Analysis

Table 2 shows the statistical description for the major variables and reports the sample size, mean, standard deviation, minimum and maximum for each variable. The results show that the minimum and maximum values for digital transformation (DT) are 0 and 48 respectively, suggesting significant differences in the degree of digital transformation between different companies, with some companies not yet having undergone digital transformation. The minimum and maximum values of digital innovation consciousness (Inno) are 0 and 2.847, respectively, with a mean of 0.494, indirectly indicating that the awareness of digital innovation among enterprise executives is not strong enough in the current digital economy environment in our country. The minimum and maximum values of enterprise innovation investment (RD) are 0 and 14.62, respectively, suggesting that some enterprises lack innovation, while others have achieved significant results in technological innovation. There are significant differences in technological innovation among different enterprises, but overall, the intensity of innovation investment is small. The mean, standard deviation, minimum, and maximum values of other control variables are within a normal range, with no significant differences in numerical distribution and no extreme outliers, preliminarily verifying the reasonableness and reliability of the data. In addition, from the perspective of executives' overseas background experience, 18% of the executives in the sample have overseas experience, with an average proportion of 2.1%.

Table 2. Main variable descriptive statistical results.

Variable	Obs	Mean	Std.Dev.	Min	Max
DT	33536	1.852	6.83	0	48
Inno	33536	0.494	0.906	0	2.847
RD	33536	1.007	2.529	0	14.62
Degree	33536	0.747	1.515	0	5
Oversea	33536	0.183	0.387	0	1
Oversea_ratio	33536	0.021	0.053	0	0.28
Region	33536	2.458	1.403	1	5
HT	33536	0.601	0.49	0	1
Market	33536	4.831	4.474	0	12.014
Size	33536	7.826	2.764	0	13.652
ROA	33536	0.034	0.075	-0.322	0.258
Tato	33536	0.642	0.486	0.024	2.769
Lev	33536	0.485	0.222	0.054	1.094
Growth	33536	0.432	1.429	-0.783	10.843
Soe	33536	0.452	0.498	0	1
Ins	33536	44.425	25.426	0	92.376
Boardsize	33536	8.144	3	0	15
Indep	33536	34.175	11.423	0	57.14
Top1	33536	31.362	17.351	0	74

Table 3 reports the correlation coefficient matrix. Before conducting basic regression analysis, to test for multicollinearity among the variables, this study uses Pearson's correlation analysis method to test the correlation among the variables. Digital innovation art and enterprise digital transformation are strongly correlated with a confidence interval of 1%, indicating that digital innovation consciousness has a positive promoting effect on enterprise digital transformation, preliminarily verifying Hypothesis 1and 2. In addition, the VIF values for all variables are less than 10, indicating that there is no problem of multicollinearity between the variables.

Table 3. PEARSON correlation analysis.

variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.DT	1															
2.Inno	0.606***	1														
3.RD	0.534***	0.649***	1													
4.Oversea	0.362***	0.641***	0.502***	1												
5.Oversea_ratio	0.328***	0.543***	0.444***	0.824***	1											
6.Degree	0.366***	0.655***	0.533***	0.670***	0.594***	1										
7.Size	0.128***	0.265***	0.134***	0.215***	0.185***	0.210***	1									
8.ROA	-0.095***	-0.141***	-0.126***	-0.124***	-0.091***	-0.126***	-0.148***	1								
9.Tato	-0.028***	-0.052***	-0.102***	-0.050***	-0.038***	-0.057***	-0.138***	0.174***	1							
10.Lev	-0.014**	0.024***	-0.093***	0.013**	-0.006	0.003	0.160***	-0.337***	0.074***	1						
11.Growth	-0.008	-0.031***	-0.022***	-0.011**	-0.020***	-0.011*	0.040***	-0.001	-0.141***	0.067***	1					
12.Soe	-0.055***	-0.010*	-0.068***	-0.049***	-0.097***	-0.032***	0.358***	-0.074***	0.029***	0.181***	0.025**	1				
13.Ins	-0.047***	0.026***	-0.076***	0.015**	0.007	0.001	0.628***	0.014**	0.003	0.135***	0.044**	0.466***	1			
14.Boardsize	0.038***	0.090***	0.038***	0.086***	0.058***	0.074***	0.773***	-0.138***	-0.119***	0.064***	0.021**	0.350***	0.547***	1		
15.Indep	0.098***	0.179***	0.130***	0.144***	0.124***	0.154***	0.757***	-0.200***	-0.130***	-0.023***	0.062**	0.220***	0.441***	0.607***	1	
16.Top1	-0.064***	-0.019**	-0.073***	-0.027**	-0.038***	-0.023***	0.544***	0.003	0.008	0.014***	0.054**	0.361***	0.690***	0.457***	0.485***	1
VIF	1.70	3.05	2.00	4.01	3.20	2.23	5.20	1.32	1.12	1.37	1.04	1.36	2.63	2.70	2.73	2.15

4.2 Baseline Regression Analysis

Table 4 reports the effects of digital innovation consciousness and management's foreign background in digital business transformation. The main explanatory variable here is digital innovation awareness (Inno),with executives' overseas background measured using the

dummy variable for executives' overseas experience (Oversea) and the proportion of executives with overseas experience (Overseas_ratio). Column (1) includes results with the dummy variable for executives' overseas experience, controlling for year and industry fixed effects, showing that digital innovation consciousness significantly enhances the degree of digital transition in companies. Column (2), building on Column (1) and further controlling for basic enterprise characteristics and other control variables, still finds that digital innovation consciousness, innovation investment, and executives' overseas background significantly improve the degree of digital transformation in companies. Column (3) shows this by including the share of managers with foreign experience, the stronger the digital innovation consciousness, the higher the degree of digital transformation remains. Similarly, Column (4) adds more control variables based on Column (3), and this conclusion still holds. These results further support Hypothesis H1. Additionally, control variables indicate that the larger the company and the stronger its development resources, the higher the degree of digital transformation.

Table 4. Influence of awareness of digital innovation and executives' background abroad on companies' digital transformation.

variable	(1)	(2)	(3)	(4)
Inno	4.827***	4.789***	4.810***	4.775***
	(0.058)	(0.059)	(0.058)	(0.059)
Oversea_dummy	0.214**	0.176*		
	(0.100)	(0.100)		
Oversea_ratio			3.318***	3.067***
			(0.634)	(0.641)
size		0.065**		0.057**
		(0.026)		(0.027)
ROA		-2.122***		-2.110***
		(0.424)		(0.424)
Tato		0.496***		0.489***
		(0.067)		(0.067)
Lev		-0.124		-0.115
		(0.154)		(0.153)
Growth		0.029		0.030
		(0.020)		(0.020)
Soe		-0.063		-0.032
		(0.066)		(0.066)
Ins		-0.005***		-0.005***
		(0.002)		(0.002)
Boardsize		-0.025		-0.024
		(0.019)		(0.019)
Indep		0.008		0.008
		(0.006)		(0.006)
Top1		-0.003		-0.003
		(0.002)		(0.002)
_cons	0.556***	0.410**	0.562***	0.414**
	(0.129)	(0.172)	(0.129)	(0.172)
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
N	33536	33536	33536	33536
adj. R2	0.492	0.494	0.493	0.494

4.3 Mechanism Test

Table 5 tests the pathway of innovation investment. Building on Model (1), it adds innovation investment (RD) and conducts a Sobel test. Table 6 displays the outcomes of the Bootstrap method based on 500 samples. Theoretical analysis suggests that enterprises with digital innovation consciousness are more likely to increase their innovation investments, thereby facilitating successful digital transition. The results of this test, as shown in Table 5, are as follows. Columns (1) and (2) show that the coefficient for Inno is 5.615 and 1.204, significant at the 1% level, respectively, indicating that digital innovation consciousness enhances the level of enterprise innovation investment. Column (3) shows that the coefficient for Inno is 4.8, significant at the 1% level, and the coefficient for RD is 0.677, also significant at the 1% level. The coefficient for Inno decreases compared to Column (1), indicating that innovation investment (RD) plays a partial mediating role in the pathway through which digital innovation consciousness promotes enterprise digital transition. This means that digital innovation consciousness enhances digital transformation through innovation investment, confirming Hypothesis H2. The Sobel test gives a Z-value of 42.28, significant at the 1% level, indicating a mediating effect. The indirect and direct effects Z-values from the Bootstrap are 16.91 and 49.09, respectively, both significant at the 1% level, further proving the existence of a mediating effect. This analysis confirms that increasing innovation investment is a pathway through which digital innovation consciousness promotes enterprise digital transformation. These findings suggest that executives who reflect a strong, broad, and enduring innovation orientation in their annual reports are more likely to make strategic decisions about the company's innovation initiatives, transforming their consciousness into specific innovation activities embedded in the company's operations.

Table 5. Path test for innovation inputs.

	DT	Inno	DT
Inno	5.615***	1.204***	4.800***
	(98.502)	(60.481)	(82.276)
RD			0.677***
			(44.474)
Size	0.087***	0.029***	0.068**
	(3.201)	(3.034)	(2.556)
ROA	-3.001***	-1.285***	-2.131***
	(-6.881)	(-8.439)	(-5.024)
Tato	0.290***	-0.309***	0.499***
	(4.195)	(-12.787)	(7.409)
Lev	-0.578***	-0.673***	-0.122
	(-3.664)	(-12.223)	(-0.795)
Growth	0.041**	0.018**	0.029
	(1.982)	(2.434)	(1.448)
Soe	-0.058	0.022	-0.073
	(-0.856)	(0.939)	(-1.110)
Ins	-0.008***	-0.003***	-0.005***
	(-4.227)	(-5.209)	(-3.082)
Boardsize	-0.027	-0.005	-0.024
	(-1.417)	(-0.701)	(-1.288)
Indep	0.006	-0.002	0.008
	(1.098)	(-1.008)	(1.375)

Top1	-0.006**	-0.003***	-0.004
	(-2.363)	(-3.640)	(-1.546)
_cons	0.830***	0.636***	0.399**
	(4.688)	(10.288)	(2.318)
Year FE	Y	Y	Y
Industry FE	Y	Y	Y
	Mediating variable: Inno		
Sobel Z		42.28***	
	Effective Mechanisms - Positive Transmission		
N	33536	33536	33536
adj. R2	0.464	0.523	0.494

To further test the intermediation of innovation inputs between digital innovation consciousness and enterprise digital transformation, this study employs a Bootstrap sampling method with 500 iterations to construct a 95% bias-corrected confidence interval. The findings are summarized in table 6, where the confidence interval for innovation orientation ranges from 1.03431 to 1.305464, not including zero, thus indicating a significant mediating effect and further validating Hypothesis H3.

Table 6. Bootstrap test for the mediation effect.

	Observde coefficient	Bootstrap Std.err	Z	P	[95% conf.interval]	
indirect effect	1.169887	0.0691732	16.91	0.000	1.03431	1.305464
direct effect	3.937261	0.0802012	49.09	0.000	3.78007	4.094453

4.4 Endogeneity and Robustness Tests

In order to validate the impact of digital innovation consciousness on enterprise digital transformation and ensure the reliability of the regression results, this paper addresses potential biases from omitted variables and endogeneity issues through specific tests detailed in Table 7.

4.4.1 Endogeneity Test.

There may be reverse causation between digital innovation consciousness and enterprise digital transformation, which could introduce an endogeneity bias. To assure the stability and reliability of the regression results, this study introduces a lagged term of digital innovation consciousness as the core explanatory variable and employs a two-stage least squares (IV-2SLS) method to circumvent potential endogeneity. Column (1) of Table 7 shows the first-stage regression results, indicating a marked significant positive relationship at the 1% level between digital innovation consciousness and the chosen instrumental variable, suggesting a valid relationship. Column (2) presents the second-stage regression results, where digital innovation consciousness continues to exert a positive influence on enterprise digital transformation, significant at the 1% level. The Kleibergen-Paap rk LM statistic for the instrument variable endogeneity test rejects the null hypothesis, and the Cragg-Donald Wald F statistic exceeds the Stock-Yogo weak instrument threshold of 16.380 at the 10% level, confirming that the instrumental variable is not weak. These analyses demonstrate robustness of benchmark regression results when considering endogeneity issues.

4.4.2 Robustness Tests.

The robustness of the findings was further tested by changing the dependent variable, adjusting the time span of the dependent variable, and employing group regression among other methods. First, following the approach of Zhang Yongjin et al. This article uses the numerical intangible assets to total intangible assets ratio as a proxy measure for enterprise digital transformation. The results of this modified dependent variable are shown in Column (3) of Table 7. Second, the study adjusts the time span of the dependent variable in the baseline regression, excluding the years 2021-2022 to remove potential policy effects, leading to a sample size of 29,344. The regression results, shown in Column (4), reveal that the coefficient estimates for digital innovation consciousness remain significantly positive across all scenarios. These results are consistent with the baseline regression results in Table 4, indicating that the econometric model constructed for this study is robust.

Table 7. Internal and stable test.

	(1)	(2)	(3)	(4)
	instrumental variable approach		Replacement of explanatory variables	Reduction of sample size
	first	second	Dta	DT
Inno		4.985***	1.275***	4.845***
		(25.282)	(48.585)	(0.059)
RD	0.026***	0.661***	0.117***	(0.016)
	(28.454)	(9.511)	(17.094)	0.606***
Size	0.022***	0.065	0.519***	(0.016)
	(13.370)	(1.385)	(43.625)	(0.023)
ROA	0.042	-2.191***	2.241***	-0.559
	(1.576)	(-3.128)	(11.740)	(0.371)
Tato	0.021***	0.537***	0.001	0.280***
	(4.962)	(4.963)	(0.031)	(0.058)
Lev	0.017*	-0.146	0.144**	0.052
	(1.758)	(-0.561)	(2.078)	(0.131)
Growth	-0.002*	0.031*	-0.040***	0.013
	(-1.762)	(1.695)	(-4.451)	(0.017)
Soe	-0.014***	-0.073	-0.073**	-0.027
	(-3.400)	(-0.603)	(-2.486)	(0.057)
Ins	-0.000	-0.006*	-0.002***	-0.003**
	(-1.452)	(-1.773)	(-2.747)	(0.001)
Boardsize	-0.001	-0.025	-0.049***	-0.012
	(-0.584)	(-0.782)	(-5.816)	(0.016)
Indep	0.000	0.008	-0.001	0.004
	(0.952)	(0.722)	(-0.515)	(0.005)
Top1	-0.000	-0.004	-0.005***	-0.001
	(-1.034)	(-1.004)	(-4.349)	(0.002)
L.Inno	0.847***			
	(223.633)			
_cons	-0.095***	-4.174***	-2.083***	0.098
	(-9.046)	(-13.327)	(-26.881)	(0.144)
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Kleibergen-Paap rk LM	21212.19			

P-Value		0.0000		
Cragg-Donald Wald F		52251.89		
N	31440	31440	33536	29344
adj. R2	0.901	0.493	0.939	0.476

4.5 Heterogeneity Analysis

To further test whether the implication of digital innovation consciousness on enterprise digital transformation varies under different circumstances, this study conducts a heterogeneity analysis at macro (regional and market), meso (industry technological attributes), and micro levels (enterprise size and executives' international background).

4.5.1 Macro Regional Heterogeneity Analysis.

Table 8 presents the results of the regression of regional heterogeneity. The sample is divided into the Northeast, East, Central, and West regions to test the impact of executives' digital innovation consciousness on enterprise digital transformation in different areas, with results shown in Table 5. Columns (1) and (2) show that the regression coefficients for digital innovation consciousness (Inno) are 3.540 and 5.258, respectively, indicating that in the Northeast and East regions, digital innovation consciousness has a more substantial promotional effect on enterprise digital transformation. Furthermore, Column (1) shows that the Northeast region's coefficient for innovation investment (RD) is 0.789, higher than other regions, suggesting that innovation investment has a more pronounced effect on digital transformation of the enterprise in the Northeast. Table 9 reports the regression results for the degree of marketization heterogeneity. In regions with a higher degree of marketization, enterprises typically face greater competitive pressure, prompting them to seek technological innovation and management improvements to maintain a competitive edge. Digital technology, as a key tool for enhancing efficiency and innovation capabilities, naturally becomes a focal point for enterprises. Highly market-oriented areas often have more mature infrastructure and technology acceptance, providing fertile ground for digital innovation. Enterprises are more likely to encounter the latest technologies and business models and have the capability and resources to implement these technologies, thereby driving product and service innovation. Additionally, consumers and partners in these regions may be more open and receptive to new technologies, further motivating enterprises to adopt digital innovations. Overall, a high-marketization environment not only provides the necessary technological and market conditions for digital innovation but also, through intense market competition, compels enterprises to seek digital means to improve operations, increase efficiency, and create new market opportunities. Such an environment fosters a stronger consciousness of digital innovation among enterprises. This paper uses the Fan Gang Marketization Index of the previous year to measure the degree of marketization, with regions above the median considered high-marketization and those at or below the median as low-marketization.

Table 8. Regional heterogeneity regression results.

	North	East	Middle	West
Inno	3.540***	5.258***	3.328***	3.267***
	(17.507)	(50.230)	(26.947)	(28.118)
RD	0.789***	0.566***	0.290***	0.208***

	(13.229)	(19.871)	(8.327)	(5.765)
Size	0.273***	0.014	0.193***	0.068
	(3.178)	(0.299)	(3.162)	(1.230)
ROA	-2.309	-1.025	-1.171	-0.624
	(-1.490)	(-1.231)	(-1.192)	(-0.740)
Tato	0.659**	0.525***	0.143	0.344**
	(2.412)	(4.468)	(0.962)	(2.199)
Lev	-0.749	0.419	-0.056	-0.407
	(-1.284)	(1.466)	(-0.160)	(-1.335)
Growth	0.050	0.014	0.027	0.042
	(1.047)	(0.404)	(0.631)	(1.226)
Soe	-1.659***	-0.238*	-0.467***	-0.159
	(-5.831)	(-1.940)	(-3.091)	(-1.096)
Ins	-0.003	-0.004	-0.003	-0.012***
	(-0.382)	(-1.062)	(-0.690)	(-2.805)
Boardsize	0.013	-0.087***	0.050	0.008
	(0.205)	(-2.766)	(1.395)	(0.221)
Indep	-0.015	0.001	-0.020*	0.008
	(-0.816)	(0.080)	(-1.652)	(0.824)
Top1	-0.020**	-0.003	-0.006	0.013***
	(-2.093)	(-0.637)	(-1.195)	(2.667)
_cons	0.632	0.817	-0.118	0.483
	(0.428)	(0.854)	(-0.067)	(0.412)
Year	Y	Y	Y	Y
Industry	Y	Y	Y	Y
N	1338	10931	3511	17756
adj. R2	0.453	0.471	0.455	0.388

The results in Table 9 indicate that in regions with a higher level of marketization, digital innovation consciousness has a more significant promotional effect on digital transformation of the business. That is, when factor and product markets are more developed, the digital innovation consciousness of enterprises can exert a more substantial positive influence through innovation investment. Moreover, in regions with a limited degree of marketization, digital innovation consciousness still significantly promotes enterprise digital transformation, and enterprises should also focus on benefiting from the practical application of digital technology.

Table 9. Heterogeneity regression results for degree of marketisation.

	(1) Low-degree marketisation	(2) High-degree marketisation	（3） Comparison of Interaction Items
Inno	5.214***	4.428***	5.188***
	(52.494)	(63.989)	(76.960)
market			0.062***
			(6.259)
Inno_market			0.072***
			(11.377)
RD	0.792***	0.472***	0.647***
	(33.112)	(23.731)	(41.976)
Size	0.066	0.066**	0.065**
	(1.364)	(2.152)	(2.474)
ROA	-2.565***	-1.115**	-1.978***

	(-3.932)	(-2.017)	(-4.668)
Tato	0.517***	0.438***	0.477***
	(4.663)	(5.325)	(7.099)
Lev	-0.556**	0.141	-0.191
	(-2.177)	(0.751)	(-1.240)
Growth	0.030	0.024	0.028
	(0.741)	(1.113)	(1.391)
Soe	0.459**	-0.313***	-0.161**
	(2.480)	(-3.809)	(-1.993)
Ins	-0.004	-0.007**	-0.005***
	(-1.624)	(-2.528)	(-3.124)
Boardsize	-0.024	-0.037*	-0.023
	(-0.635)	(-1.802)	(-1.233)
Indep	0.014	-0.001	0.008
	(1.348)	(-0.109)	(1.401)
TOP1	-0.005	-0.001	-0.003
	(-1.252)	(-0.282)	(-1.107)
_cons	0.544**	2.193	0.416**
	(2.113)	(1.433)	(2.418)
Year FE	Y	Y	Y
Industry FE	Y	Y	Y
N	15345	18191	0.416**
adj. R2	0.536	0.442	(2.418)

4.5.2 Meso-level Industry Technological Attribute Heterogeneity Group Test.

Table 10 reports the regression results for industry heterogeneity analysis. In addition to macro-regional influencing factors, the different technological attributes of industries at the meso level may also cause varying effects of digital innovation consciousness on enterprise digital transformation. For enterprises in different industries, digital innovation strategic consciousness may not always be the key factor to success. Therefore, this study conducts a heterogeneity analysis at the meso-industry technological attribute level. Following the approach of Wu Fei et al. (2023), high-tech enterprises are divided into three categories and 19 subcategories based on different industry types. The three categories are manufacturing (C), information transmission, software and information technology services (I), and scientific research and technical services (M); the 19 subcategories include C25, C26, C27, C28, C29, C31, C32, C34, C35, C36, C37, C38, C39, C40, C41, I63, I64, and M73. Non-high-tech enterprises are those not included in the above attributes. The industry is divided into high-tech and non-high-tech. Table 8 shows the regression results. Columns (1) and (2) indicate that in high-tech industries, digital innovation consciousness plays a significant role in enterprise digital transformation, and the degree of innovation investment is much higher than in non-high-tech industries. Moreover, to ensure the robustness of the conclusions, this study also uses an interaction term for testing. The results show that the regression coefficient of the interaction term (Inno_HT) is 0.195 and is significant at the 1% level. This suggests that compared to non-high-tech enterprises, the promotional effect of digital innovation consciousness on the digital transformation of high-tech enterprises is significantly enhanced. This study believes that high-tech enterprises themselves place great emphasis on digital transformation and rely more heavily on innovation investment.

Table 10. Industry Heterogeneity Regression Results.

	(1) technology sector DT	(2) Non-technology-based industries DT	(3) Comparison of Interaction Items DT
Inno	5.522***	4.002***	4.678***
	(63.707)	(59.805)	(63.178)
HT			-1.960***
			(-4.368)
Inno_HT			0.195***
			(2.659)
RD	0.810***	0.250***	0.659***
			0.195***
			(2.659)
	(39.120)	(7.691)	(39.618)
Size	0.147***	-0.026	0.068***
	(3.821)	(-0.818)	(2.588)
ROA	-3.042***	0.543	-2.179***
	(-5.110)	(1.014)	(-5.132)
Tato	0.711***	0.440***	0.494***
	(6.708)	(6.113)	(7.331)
lev	-0.133	-0.179	-0.133
	(-0.614)	(-0.945)	(-0.868)
Growth	0.021	0.026	0.028
	(0.533)	(1.424)	(1.392)
Soe	0.028	-0.299***	-0.074
	(0.310)	(-3.603)	(-1.125)
Ins	-0.006***	-0.005**	-0.005***
	(-2.621)	(-2.082)	(-3.101)
Boardsize	-0.068**	0.032	-0.025
	(-2.446)	(1.476)	(-1.312)
Indep	-0.000	0.024***	0.008
	(-0.035)	(3.418)	(1.368)
Top1	-0.010***	0.004	-0.003
	(-3.117)	(1.361)	(-1.482)
_cons	0.139	-0.186	0.412**
	(0.193)	(-1.033)	(2.389)
Year	Y	Y	Y
Industry	Y	Y	Y
N	20149	13387	33536
adj. R2	0.519	0.417	0.494

4.5.3 Micro-level Heterogeneity Group Test.

Table 11 reports the heterogeneity analysis results for enterprise size. It can be observed that the regression coefficient of digital innovation consciousness is larger for large enterprises than for small ones, indicating that large enterprises are more willing to undergo digital transformation and have a higher success rate. This may be because large enterprises have more substantial financial strength, more abundant talent reserves, higher technical levels, and stronger risk-bearing capabilities. Therefore, large enterprises have a stronger consciousness of digital transformation.

Table 11. Regression results for firm size heterogeneity.

	(1) Large-scale enterprises DT	(2) Small-scale enterprises DT	(3) Comparison of Interaction Items DT
Inno	5.146***	3.808***	1.888***
	(64.328)	(49.199)	(10.054)
RD	0.751***	0.599***	0.730***
	(37.096)	(28.848)	(47.070)
Size	0.025	0.091**	-0.097***
	(0.518)	(2.040)	(-3.434)
Inno_size			0.312***
			(16.303)
ROA	-1.546**	-1.693***	-2.452***
	(-2.012)	(-4.658)	(-5.797)
Tato	0.733***	0.119*	0.531***
	(6.797)	(1.842)	(7.922)
Lev	0.105	-0.328**	-0.116
	(0.380)	(-2.394)	(-0.755)
Growth	0.048	-0.003	0.032
	(1.634)	(-0.154)	(1.579)
Soe	-0.163*	-0.058	-0.049
	(-1.747)	(-0.791)	(-0.754)
Ins	-0.008***	-0.001	-0.007***
	(-2.863)	(-0.577)	(-3.871)
Boardsize	-0.060**	0.046**	-0.018
	(-2.322)	(1.978)	(-0.951)
Indep	0.012	0.003	0.007
	(1.449)	(0.464)	(1.293)
Top1	-0.004	-0.000	-0.003
	(-1.162)	(-0.174)	(-1.113)
		(.)	(.)
_cons	-0.707	0.555***	0.356**
	(-0.727)	(4.037)	(2.075)
N	20115	13421	33536
adj. R2	0.511	0.504	0.498

Table 12 presents the heterogeneity regression results for executives' overseas experience. Executives with overseas experience have stronger digital innovation consciousness compared to those without. This could be because executives with overseas experience typically possess a broader international perspective and a more open mindset. They may have been exposed to advanced technologies and management concepts abroad and understand the application and trends of digitalization on a global scale. This international perspective and experience make them more inclined to bring these advanced concepts and practices back to their home country to drive the digital transformation of their enterprises. Additionally, overseas experience might endow executives with more technical knowledge and management skills, which are crucial for understanding and implementing digital transformation. They are likely more familiar with the potential and limitations of digital technology and how to effectively manage the changes during the digital transformation process.

Table 12. Regression results for heterogeneity of executives' overseas experience.

	(1) Overseas experience DT	(2) No-overseas experience DT	(3) Comparison of Interaction Items DT
Inno	4.080***	3.955***	3.661***
	(25.142)	(73.804)	(45.421)
Oversea			-3.049***
			(-16.242)
Inno_Oversea			2.078***
			(20.281)
RD	0.460***	0.624***	0.677***
	(11.302)	(38.912)	(44.595)
Size	0.562***	-0.004	0.078***
	(5.216)	(-0.196)	(2.974)
ROA	-1.863	-0.667**	-1.983***
	(-1.266)	(-2.168)	(-4.701)
Tato	2.116***	0.073	0.493***
	(6.771)	(1.612)	(7.366)
Lev	-2.742***	0.186*	-0.135
	(-4.027)	(1.792)	(-0.882)
Growth	0.158*	0.011	0.030
	(1.767)	(0.805)	(1.527)
Soe	-0.168	-0.152***	-0.061
	(-0.648)	(-3.339)	(-0.933)
Ins	-0.029***	-0.000	-0.005***
	(-4.029)	(-0.417)	(-3.074)
Boardsize	0.066	-0.037***	-0.035*
	(0.809)	(-2.874)	(-1.846)
Indep	0.069***	-0.004	0.006
	(3.076)	(-0.947)	(1.118)
Top1	-0.026***	0.003*	-0.003
	(-2.622)	(1.786)	(-1.247)
_cons	-3.990*	0.266**	0.212
	(-1.933)	(2.389)	(1.238)
N	6151	27385	33536
adj. R2	0.535	0.434	0.500

4.6 Long-term Sustained Effect Test

Table 13 shows the results of the long-term sustained effect test. To verify the impact of digital innovation consciousness on enterprise digital transformation, this study conducted a test for long-term sustained effects. The digital innovation consciousness was lagged by one, two, and three periods, and the regression coefficients were all highly significant positive at the 1% level, indicating that digital innovation consciousness has a long-term sustained effect on digital transformation of the enterprise. This suggests that the influence of digital innovation consciousness is not transient but continues to affect the adaptive capacity of enterprises and transform in the digital age over an extended period.

Table 13. Long-term persistence tests.

	(1) DT	(2) DT	(3) DT
L.Inno	4.220***		
	(62.678)		
L2.Inno		3.987***	
		(50.417)	
L3.Inno			4.153***
			(42.446)
RD	0.789***	0.867***	0.918***
	(49.069)	(51.739)	(52.625)
Size	0.174***	0.254***	0.317***
	(6.004)	(8.108)	(9.359)
ROA	-1.983***	-2.072***	-2.070***
	(-4.215)	(-3.992)	(-3.644)
Tato	0.641***	0.769***	0.893***
	(8.544)	(9.249)	(9.852)
Lev	-0.062	-0.024	0.018
	(-0.365)	(-0.132)	(0.087)
Growth	0.020	0.016	0.013
	(0.918)	(0.669)	(0.489)
Soe	-0.141**	-0.194**	-0.234***
	(-1.975)	(-2.510)	(-2.804)
Ins	-0.006***	-0.007***	-0.008***
	(-3.354)	(-3.364)	(-3.637)
Boardsize	-0.028	-0.031	-0.032
	(-1.349)	(-1.366)	(-1.304)
Indep	0.010	0.010	0.013*
	(1.556)	(1.538)	(1.721)
Top1	-0.005*	-0.006**	-0.007**
	(-1.802)	(-2.143)	(-2.369)
_cons	0.065	-0.124	-0.436*
	(0.348)	(-0.593)	(-1.757)
N	31440	29344	27248
adj. R2	0.459	0.440	0.431

5. Research Conclusions and Policy Recommendations

This study, using Chinese listed companies from 2007 to 2022 as the research sample, applies regression models and intermediary effect models to study the relation between innovation awareness and digital Transformation of Enterprises. The study finds that the digital transformation of companies has a significant positive influence on the digital transformation of companies, and this conclusion remains robust after a series of robustness tests and endogeneity problem treatments. The mechanism of its impact is that digital innovation consciousness will increase the intensity of innovation investment, thereby promoting enterprise digital transformation, and it has a sustained long-term effect on the company's digital transformation. In the analysis of heterogeneity, from a macro perspective, the digital innovation consciousness and innovation investment in the Northeast and Eastern regions are stronger than other regions. Firms with a high degree of marketization have higher digital

innovation consciousness than those with a low level of marketization. From a meso perspective, technology-based industries have a stronger digital creative consciousness. From a micro perspective, compared with small-scale enterprises, the impact of digital innovation consciousness on enterprise digital transformation is greater in large-scale enterprises. In addition, executives with experience abroad have a stronger influence on enterprise digital transformation with their digital innovation consciousness than those without overseas experience.

Based on the above findings, the following policy recommendations are proposed: First, given the positive impact of digital innovation awareness on the company's digital transformation and the moderating effect of experience abroad, enterprises should pay attention to innovation orientation and cultivate executives' digital innovation consciousness. At the same time, enterprises should design and implement incentive mechanisms to reward executives and teams that can successfully promote digital projects or bring business growth through technological innovation. This can enhance the innovation consciousness and enthusiasm of the entire organization and gradually form an open and innovative corporate culture. Enterprises should also encourage executives to participate regularly in national and foreign conferences related to digital and training courses to keep abreast of the latest technological trends and master innovative tools. This not only helps to enhance personal capabilities but also helps enterprises maintain a leading position in digital transformation. Second, since digital innovation consciousness affects enterprise digital transformation through innovation investment, the government should provide R&D funding support, tax reductions, and technical consulting services. These measures can reduce the cost of innovation for companies and increase the enthusiasm for innovation investment. Third, considering the influence of heterogeneity such as region, industry, and market, the government should promote the balanced development of regional digitalization, pay special attention to technology-based industries and large-scale enterprises, and improve the level of marketization. For the active characteristics of digital transformation in the Northeast and Eastern regions, their successful experiences should be promoted in the central and western regions and in other regions to reduce the digital gap between regions. At the same time, increase technical and financial support for the more backward regions to enhance their digital innovation consciousness and capabilities. As technology-based industries and large-scale enterprises play a leading role in digital transformation, the government should particularly support their digital projects, such as by setting up a technology innovation fund to provide these enterprises with necessary technical and financial support.

References

[1] Ko, Andrea, et al. "Influencing factors of digital transformation: management or IT is the driving force?." International Journal of Innovation Science 14.1 (2022): 1-20.

[2] Wang, Siwei, et al. "The effects of government support on enterprises' digital transformation: Evidence from China." Managerial and Decision Economics 44.5 (2023): 2520-2539.

[3] Proksch, Dorian, et al. "The influence of a digital strategy on the digitalization of new ventures: The mediating effect of digital capabilities and a digital culture." Journal of small business management 62.1 (2024): 1-29.

[4] March J G，Simon H A. Organizations［M］. New York：John Wiley & Sons Inc,1958.

[5] Hambrick D C，Mason P A.Upper echelons：The organiza- tion as a reflection of its top managers ［J］. Academy of Management，1984，9（2）： 193-206.
[6] Marcel, Jeremy J., Pamela S. Barr, and Irene M. Duhaime. "The influence of executive cognition on competitive dynamics." Strategic Management Journal 32.2 (2011): 115-138.
[7] Rindova, Violina P. "What corporate boards have to do with strategy: A cognitive perspective." Journal of management studies 36.7 (1999): 953-975.
[8] Sarfraz, Muddassar, Bin He, and Syed Ghulam Meran Shah. "Elucidating the effectiveness of cognitive CEO on corporate environmental performance: the mediating role of corporate innovation." Environmental Science and Pollution Research 27.36 (2020): 45938-45948.
[9] Li, Hui, et al. "Demonstrating the impact of cognitive CEO on firms' performance and CSR activity." Frontiers in Psychology 11 (2020): 278.
[10] Narayan, Somendra, Jatinder S. Sidhu, and Henk W. Volberda. "From attention to action: The influence of cognitive and ideological diversity in top management teams on business model innovation." Journal of Management Studies 58.8 (2021): 2082-2110.
[11] Attah-Boakye, Rexford, et al. "The effects of top management team strategic cognition on corporate financial health and value: an interactive multi-dimensional approach." The European Journal of Finance 29.13 (2023): 1461-1492.
[12] Liang S, Li T. Can digital transformation promote innovation performance in manufacturing enterprises? The mediating role of R&D capability[J]. Sustainability, 2022, 14(17): 10939.
[13] Zhang G, Gao Y, Li G. Research on digital transformation and green technology innovation—evidence from China's listed manufacturing enterprises[J]. Sustainability, 2023, 15(8): 6425.
[14] Huang Shanshan,Shao Yinghong. Executive Innovation Awareness, Corporate Innovation Investment and Innovation Performance - An Empirical Study Based on China's GEM Listed Companies[J]. East China Economic Management,2017,31(02):151-157.
[15] Jin Xiaoshu. Executives' overseas experience and corporate digital transformation[J/OL]. Operation and Management,1-17[2024-04-16].