IJMR | International Journal of Multidisciplinary Research
Международный институт управления и предпринимательства
Research Article Print ISSN 3105-8884 Online ISSN 3105-8892 December 2025, Vol. 1, No. 3
https://doi.org/10.65231/ijmr.v1i3.109

Research on the Threshold Effect of Digital Transformation on Corporate Performance in Manufacturing Enterprises

Tian Xinyang

School of Business Administration ,University of science and technology Liaoning , An Shan, China

KEYWORDS

Digital Transformation; Corporate Performance; Manufacturing Enterprises; Threshold Effect

ABSTRACT

In the digital economy era, as a pillar of China's economy, the manufacturing sector must pursue digital transformation, which is crucial to high-quality development and modernization goals. Using Shanghai and Shenzhen A-share manufacturing enterprises from 2015 to 2023 as samples, this paper explores the threshold effect of digital transformation on corporate performance, analyzes heterogeneity, relevant moderating and mediating roles, and provides suggestions for enterprises' transformation.

INTRODUCTION

Guided by national policies, China's digital economy has leapfrogged as a key economic engine. Corporate performance is critical to overall economic progress. With advancing digitalization, academic research on their link has deepened yet divided: some scholars argue for a linear positive correlation—e.g., Chen Xu, Jiang Yao, et al. hold it boosts performance via cost optimization and efficiency gains [1]; others note transformation cannot be rushed—Fu Ying, Xu Qi, et al. found misalignment with enterprises' resources/capabilities often reduces performance [2]. Current research mostly focuses on linear relationships, with no consensus on nonlinear dynamics or mechanisms. As a national economic pillar, exploring this threshold effect in manufacturing is vital. Drawing on relevant theories, this paper uses a threshold model to verify the "first promoting, then inhibiting" nonlinear relationship, clarifies mechanisms of variables like financing constraints and the threshold value, enriches theories, and provides enterprise transformation guidance to mitigate risks and enhance performance.

1.Theoretical Analysis and Research Hypotheses

1.1.The Threshold Effect of Digital Transformation on Corporate Performance

Digital resources, an emerging production factor, have an inverted U-shaped "first promoting, then inhibiting" impact on corporate performance due to the law of diminishing marginal returns, with a significant threshold effect. This can be analyzed from two core dimensions: technology and organization.

In the early stage, technological empowerment delivers tangible benefits: data infrastructure breaks barriers, cloud computing and big data integrate multi-business data, speed up information flow and cross-departmental sharing, and enhance decision-making efficiency. Meanwhile, digital-tech integration with operations replaces repetitive labor with automation and intelligence, achieving standardized production, economies of scale, and lower unit costs.

In the later stage, the "digital paradox" emerges: incompatible interfaces across systems create data silos, compelling enterprises to invest heavily in custom interfaces. High costs and delays in cross-platform integration seriously hamper supply chain and sales response efficiency. Rapid tech iteration brings dual pressures: system maintenance and

* Corresponding author. E-mail address:3293420635@qq.com

Received date: December 01, 2025; Revised manuscript received date: December 10, 2025; Accepted date: December 20, 2025; Online publication date: December 31, 2025.

upgrades consume significant resources, crowding out innovation funding. When iteration pace exceeds enterprises' absorption capacity, they fall into a "obsolete upon introduction" vicious cycle, hindering the conversion of tech input into outputs.

Early on, digitalization spurs organizational change: traditional "pyramid" structures shift to "networked" ones, shortening response cycles and breaking hierarchical barriers. A "data-driven culture" reforms management thinking, shifting decision-making from "experience-driven" to "data-driven." It also helps enterprises deepen customer ties, co-construct a digital supplier ecosystem, and build an integrated supply-production-marketing model.

In the later stage, organizations show a "rejection response" to tech shocks: organizational inertia and path dependence cause delayed structural adjustments, sparking employee resistance and talent drain. Moreover, digital system complexity fosters strict control mechanisms that conflict with digitalization's need for agility, stifling creativity and flexibility, and undermining the transformative organizational environment—ultimately dragging down performance.

Therefore, this paper proposes Hypothesis H1: Digital transformation of manufacturing enterprises has a threshold effect on corporate performance.

1.2.Moderating Effect of Digital Transformation on Corporate Performance

1.2.1. Moderating Effect of Financing Constraints

Financing constraints moderate the relationship between digital transformation and corporate performance through two aspects, ultimately showing a differentiated effect: "low constraints promote growth, while high constraints inhibit it."

Firstly, they affect input-output capacity. Under low constraints, enterprises have strong capital access, enabling sufficient investment in advanced technologies and equipment for digital transformation without crowding out resources for core links like production and sales. This ensures coordinated progress of transformation and daily operations, maximizing digitalization's performance-enhancing effect. Conversely, high constraints leave enterprises short of transformation funds; forced advancement causes resource misallocation, leading to capital turnover difficulties, equipment idleness, unsold products, and reduced performance.

Secondly, financing constraints restrict strategic adjustment flexibility. In the digital era with rapid market and technological iteration, enterprises with low constraints can flexibly raise funds to adjust transformation plans, adapt to market changes and organizational needs, and optimize paths to boost performance. However, those with high constraints, limited by capital, struggle to make dynamic adjustments and can only stick to existing plans, making path deviations likely and preventing digital transformation from empowering performance.

Based on this, this paper proposes Hypothesis H2: Financing constraints play a moderating role in the threshold effect of digital transformation on corporate performance in manufacturing enterprises.

1.2.2.Moderating Effect of Agency Costs

Agency costs significantly moderate the relationship between digital transformation and corporate performance: transformation boosts performance under low agency costs but inhibits it under high costs.

Under low agency costs, enterprises feature efficient information communication—digital transformation-related information is transmitted accurately and timely, facilitating progress tracking, problem-solving, and scientific decision-making to enhance transformation success. Sound supervision and goal-aligned incentives align managers' and shareholders' interests, enabling resource allocation based on overall corporate goals, avoiding delays/waste, and driving efficient transformation. Additionally, a good governance structure attracts external resources, creating a favorable environment for digitalization and improving performance.

Under high agency costs, poor inter-departmental information flow, coupled with information asymmetry and incomplete contracts, makes it hard for external shareholders to select optimal management or supervise them effectively. This leads to managers seizing control, misallocating resources for personal gain, and wasting resources in transformation. Moreover, if managers' incentives are decoupled from long-term corporate

performance, they may prioritize personal interests over transformation goals, leaving digitalization without proper direction or sufficient support and ultimately hindering performance improvement.

Thus, this paper proposes Hypothesis H3: Agency costs play a moderating role in the threshold effect of digital transformation on corporate performance in manufacturing enterprises.

1.3.Mediating Effect of Digital Transformation on Corporate Performance

1.3.1.Mediating Effect of Organizational Resilience

Organizational resilience is a core organizational capability of enterprises, enabling them to address crises and resist risks in an uncertain environment [3], stabilize operational rhythms, and activate resource advantages. Enterprises with strong resilience have competitive advantages such as rapid environmental responsiveness and flexible structures. Their three dynamic capabilities—perception, integration and coordination, and learning—work synergistically to enhance risk resistance, optimize operational efficiency and decision-making quality, and inject sustained momentum into performance growth.

However, the effective exertion of organizational resilience relies on a mature and stable organizational structure and operational system. The core logic of digital transformation, by contrast, is to break this original stability and drive disruptive changes [4]. Such transformation triggers multiple uncertain shocks; technological dependence during the transformation period is also prone to deriving various risks, generating a "digital disempowerment" effect [5] that weakens organizational resilience's shock resistance. In addition, substantial resource investment in the early stage of digital transformation crowds out the redundant resources required to maintain resilience, restricting its restoration and effectiveness and thereby hindering its positive supporting role in corporate performance.

Therefore, this paper proposes Hypothesis H4: Organizational resilience plays a mediating role in the promoting effect of digital transformation on corporate performance.

1.3.2. Mediating Effect of Technological Innovation Input

Digital transformation is not a linear value-adding process but exhibits a significant threshold effect. Beyond the threshold, "post-threshold redundancy" tends to occur due to inadequate matching of funds, technologies, human resources, and organizational resources, triggering enterprises' "R&D expansion inertia"—stemming from path dependence in resource allocation. Driven by innovation-oriented cognitive inertia and industry competition pressure, management tends to channel redundant resources into R&D, continuously increasing technological innovation input even amid late-stage transformation resource constraints.

The "current cost characteristics" of technological innovation input (long payback period, high risk, and resource intensity) lead it to compete for resources with late-stage digital transformation needs such as system optimization and operation maintenance upgrades. Coupled with the financial pressure from early-stage investment, this forms "dual cost pressure," amplifying the inhibitory effect of transformation on performance. Existing studies support this: Dai Xiaoyong and Cheng Liwei found that excessive R&D input weakens its promotional effect on performance [6]; Han Xianfeng et al. noted that overly high R&D intensity causes resource misallocation and inhibits corporate performance [7].

Therefore, this paper proposes Hypothesis H5: Technological innovation input plays a mediating role in the inhibitory effect of digital transformation on corporate performance.

2.Empirical Design

2.1.Sample Selection and Data Sources

In view of China's official proposal of the concept of digital transformation in 2015, as well as the availability and effectiveness of data, this paper selects data of Shanghai and Shenzhen A-share manufacturing enterprises from 2015 to 2023 to construct a balanced panel data, and studies the threshold effect of digital transformation on corporate performance in manufacturing enterprises. The data are mainly from the CSMAR Database.

2.2.Variable Definition

This paper takes corporate performance (Roa) as the dependent variable; digital transformation (Dt) as the independent variable; financing constraints (ww) and agency costs (Cr) as moderating variables; and organizational resilience (Re) and technological innovation input (Rd) as mediating variables; enterprise age (Age), enterprise growth (Growth), asset-liability ratio (Lev), fixed asset ratio (Far), cash recovery rate of assets (Cash), net asset per share (Navps), and enterprise size (Size) as control variable.

Variable Name	Meaning	Calculation Method
Dt	Digital Transformation	Natural logarithm of digital transformation word frequency
Roa	Return on Assets	Net profit / Total assets
Age	Enterprise Age	Natural logarithm of enterprise age
Growth	Enterprise Growth	Operating income growth / Operating income of the previous year
Lev	Asset-Liability Ratio	Total liabilities / Total assets
Far	Fixed Asset Ratio	Fixed assets / Total assets
Cash	Cash Recovery Rate of Assets	Net cash flow from operating activities / Total assets
Size	Enterprise Size	Natural logarithm of total assets of the enterprise
Navps	Net Asset per Share	Net assets / Number of common shares
ww	Financing Constraints	-WW index
Cr	Agency Costs	Administrative expenses / Operating income
Re	Organizational Resilience	Calculated by entropy weight method
Rd	Technological Innovation Input	0.3791 × R&D investment level + 0.6209 × Proportion of R&D personnel

Table.1. Variable Description

2.3.Model Construction

This paper constructs a single threshold regression model (1) as the basic model.

$$Roa = \beta_0 + \beta_1 Dt \times 1(Dt < r) + \beta_2 Dt \times 1(Dt \geq r) + \sum X + \varepsilon \quad (1)$$

Where Roa represents the dependent variable corporate performance, Dt represents the independent variable digital transformation, r represents the single threshold value, 1() represents the indicator function, which takes the value of 1 when the condition in the bracket is satisfied and 0 otherwise. ∑X represents control variables such as Age, Growth, Lev, Far, Cash, Size, and Navps, and ε represents the residual term. Dt is the threshold variable.

3. Empirical Test and Result Analysis

3.1.Threshold Effect Test of Digital Transformation on Corporate Performance

3.1.1. Analysis of Test Results

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single Threshold	19.80	0.0033	10.0568	14.2560	17.7751

Table.2. Test Results of Threshold Effect of Digital Transformation on Corporate Performance

Threshold Value	95% Confidence Interval
4.5218	(4.4424, 4.6195)

Table.3. Threshold Estimation Results of Threshold Effect of Digital Transformation on Corporate Performance

From the test results in Table.2. and Table.3. it can be seen that there is a single threshold effect of digital transformation on corporate performance, with a threshold value of 4.5218 and a p-value of 0.0033 < 0.01, which is significant at the 1% significance level.

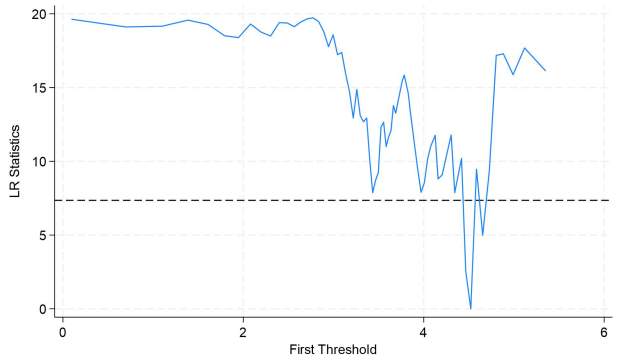

Fig.1. Likelihood Ratio Function Graph of Threshold Effect of Digital Transformation on Corporate Performance

According to Fig1., the lowest point of the LR statistic corresponds to the true threshold value, and the dashed line represents the critical value of 7.3523. Since the critical value of 7.3523 is significantly greater than the single threshold value, and the LR statistic corresponding to this threshold value is 0, it can be considered that the above threshold value is true and effective.

Variable	Regression Coefficient	t-value
Age	-0.00367***	(0.000434)
Lev	-0.227***	(0.0199)
Cash	0.209***	(0.0466)
Size	0.0314***	(0.00564)
Growth	0.0000804***	(0.0000271)
Far	-0.132***	(0.0161)
Navps	0.00133**	(0.000645)
Dt＜4.5218	0.000673*	(0.000399)
Dt ≥ 4.5218	-0.00216**	(0.000941)

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

Table.4. Parameter Regression Results of Panel Threshold Model of Digital Transformation on Corporate Performance

According to the parameter regression results, when the value of digital transformation is less than 4.5218, the coefficient of digital transformation on corporate performance is 0.000673, which is significantly positive at the 10% significance level; when the value of digital transformation is greater than 4.5218, the coefficient of digital transformation on corporate performance is -0.00216, which is significantly negative at the 5% significance level. Thus, Hypothesis H1 is verified, that is, the impact of digital transformation on corporate performance presents a threshold effect of first promoting and then inhibiting.

From the influence coefficient of the threshold regression interval results, it can be seen that before reaching the threshold value, digital transformation has a positive impact on corporate performance, but its coefficient is much smaller than the absolute value of the coefficient after the threshold. This may be because digital transformation is a long-term and gradual process, and the investment in digital transformation is difficult to achieve results quickly. When digital transformation reaches the threshold value, the resource misallocation and occupation caused by digital transformation are likely to have a serious impact on the normal operation of the enterprise. Therefore, the inhibition speed of digital transformation on corporate performance is faster than the promotion speed.

3.1.2. Endogeneity Test

Firstly, enterprises with high performance generally have more resources for digital transformation, which may lead to reverse causality; secondly, there may be unobserved factors that affect both digital transformation and corporate performance, and the omission of such variables is also likely to lead to endogeneity problems. Therefore, this paper uses the lagged term of digital transformation as an instrumental variable for endogeneity test, denoted by L.Dt. The lagged term of digital transformation is highly correlated with the current digital transformation, and past digital transformation decisions have no causal relationship with the current random disturbance term, which meets the selection conditions of instrumental variables. The test results are as follows:

	(1)first stage Dt	(2)second stage Roa
VARIABLES		
L.Dt	0.4192***	
	(14.00)	
Age	-0.0116***	-0.0006***
	(-5.52)	(-5.10)
Growth	0.0274**	0.0008
	(2.12)	(1.59)
Lev	0.1371	-0.1487***
	(1.53)	(-14.91)
Far	-1.4022***	-0.0564***
	(-10.22)	(-7.66)
Navps	-0.0087**	0.0013***
	(-2.48)	(5.38)
Cash	0.0588	0.3534***
	(0.26)	(6.60)

Size	0.1581***	0.0150***
	(8.36)	(11.51)
Dt		-0.0043***
		(-3.88)
Constant	-1.2437***	-0.2306***
	(-3.49)	(-9.38)
Kleibergen-Paap rk LM statistic	309.513***	
Cragg-Donald Wald F statistic	2763.914(Critical value = 16.38)	
Observations	9,480	9,480
R-squared		0.319

Table.5.Endogeneity Test Results

The Kleibergen-Paap rk LM statistic is 309.513 which is significant at the 1% significance level, rejecting the null hypothesis of "underidentification". It indicates that the instrumental variable L.Dt is correlated with the endogenous variable Dt, satisfying the "correlation condition" of instrumental variables, and the identification is effective. The Cragg-Donald Wald F statistic = 2763.914 is much greater than the critical value of 16.38 for 10% bias in the Stock-Yogo weak ID test, indicating that the instrumental variable L.Dt has a strong correlation with the endogenous variable Dt, and there is no "weak instrumental variable" problem, meeting the requirements of a strong instrumental variable.

In the test results of the first-stage regression (1), the coefficient of the instrumental variable L.Dt on the endogenous variable Dt is 0.4192*** (t-value = 14.00), which is significantly positive, further verifying the strong correlation between the instrumental variable and the endogenous variable, and there is no weak instrumental variable problem; in the test results of the second-stage regression (2), the coefficient of the endogenous variable Dt on the dependent variable Roa is -0.0043*** (t-value = -3.88), with a high significance level, indicating that the instrumental variable regression result is stable and effective. Moreover, this endogeneity test is the instrumental variable regression of the overall sample. The significantly negative correlation result in the second stage (2) is consistent with the threshold effect test results of weak positive (coefficient 0.000673, close to 10% significance) and strong negative (coefficient -0.0216, 5% significance). That is, the significance of -0.0043*** is the average result of the "weak positive before the threshold + strong negative after the threshold". Therefore, the regression results can indicate that there is no significant endogeneity problem in this paper.

3.1.3. Robustness Test

The dependent variable corporate performance is replaced by Return on Total Assets (Rota) for measurement (its calculation formula is: (Total profit + Financial expenses) / Average total assets), and the same model (1) is used to test the robustness of the threshold effect of digital transformation on corporate performance.

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single Threshold	16. 58	0.0133	11.4132	13.5187	16.7552

Table.6. Threshold Effect Test Results of Replacing Dependent Variable

Threshold Value	95% Confidence Interval
4.5218	（4.4424,4.6195）

Table.7. Threshold Value Test Results of Replacing Dependent Variable

From the test results shown in Table.6. and Table.7., there is a single threshold value of 4.5218, and the p-value is 0.0133, which is less than 0.05, significant at the 5% significance level.

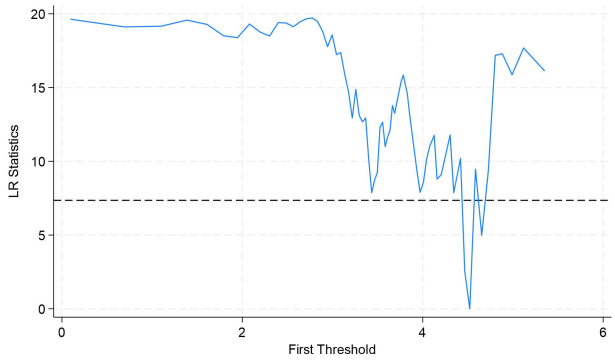

Fig.2. Likelihood Ratio Function Graph of Replacing Dependent Variable

It can also be seen from Fig.2. that the critical value of 7.3523 is significantly greater than the single threshold value, and the LR statistic corresponding to this threshold value is 0, so it can be considered that the above threshold value is true and effective.

Variable	Regression Coefficient	t-value
Age	-0.00473***	(0.000455)

Lev	-0.206***	(0.0208)
Cash	0.237***	(0.0538)
Size	0.0328***	(0.00581)
Growth	0.0000791***	(0.0000268)
Far	-0.131***	(0.0174)
Navps	0.00151**	(0.000683)
Dt＜4.5218	0.000810*	(0.000436)
Dt ≥ 4.5218	-0.00198**	(0.001000)

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

Table.8. Parameter Robustness Regression Results of Replacing Dependent Variable

From the regression results in Table.8., it can be seen that when the value of digital transformation is less than 4.5218, the coefficient of digital transformation on corporate performance is 0.000810, that is, for each 1-unit increase in digital transformation, corporate performance increases by 0.000810 units; when the value of digital transformation is greater than 4.5218, the coefficient of digital transformation on corporate performance is -0.00198, that is, for each 1-unit increase in digital transformation, corporate performance decreases by 0.00198 units.

Thus, after replacing the measurement indicator of the dependent variable, the test results are still significant.

3.2. Heterogeneity Analysis

3.2.1. Human Capital Utilization Efficiency

Differences in human capital utilization efficiency are also one of the variables leading to the differentiation of the impact of enterprise digital transformation on corporate performance. The logic of its impact lies in: whether digital transformation can bring corporate performance is not determined by the technology itself, but depends on whether human capital can effectively absorb, adapt to, and control new technologies to maximize the effectiveness of digital technology. When the utilization efficiency of human capital is high, digital input is more likely to be converted into output to improve corporate performance. On the contrary, when the utilization efficiency of human resources is low, it often means that the enterprise's digital technology is difficult to match with human resources, which is likely to cause problems such as internal organizational friction, loss of human resources, and technology idleness, ultimately affecting the improvement of corporate performance.

Therefore, this paper proposes Hypothesis H6: The impact of digital transformation on corporate performance varies with different human capital utilization efficiency.

Referring to the research of Bai Fuping and Liu Donghui , this paper uses the human capital appreciation coefficient to measure human capital utilization efficiency. The human capital appreciation coefficient is the ratio of the enterprise's human capital to the enterprise's value-added. Among them, human capital is measured by the "cash paid to employees and on behalf of employees" in the cash flow statement of listed companies, and the calculation formula of enterprise value-added is: Enterprise value-added = Total profit + Employee compensation payable + Financial expenses. After dividing the data into two parts according to the level of human capital utilization efficiency, the test results are as follows:

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single Threshold	22.01	0.0067	10.6420	12.3940	17.4374

Table.9. Threshold Effect Test Results of Digital Transformation on Corporate Performance with Low Human Capital Utilization Efficiency

Threshold Value	95% Confidence Interval
4.6634	（4.5109,4.7707）

Table.10. Threshold Value Estimation of Digital Transformation on Corporate Performance with Low Human Capital Utilization Efficiency

From the test results in Table.9. and Table.10., there is a single threshold value of 4.6634, and the P-value is 0.0067, which is less than 0.01, significant at the 1% significance level.

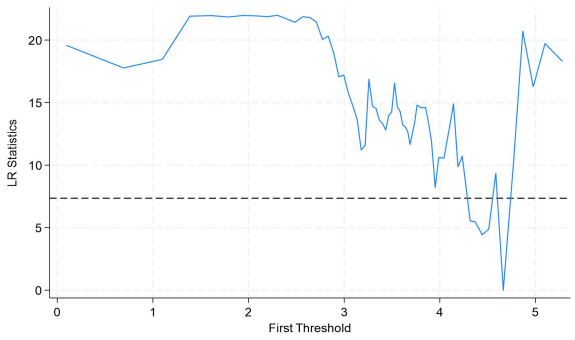

Fig.3. Likelihood Ratio Function Graph with Low Human Capital Utilization Efficiency

It can be seen from Fig.3. that there is a threshold value lower than the critical value of 7.3523, and the LR statistic

corresponding to this threshold value is 0, so it can be considered that the above threshold value is true and effective.

Variable	Regression Coefficient	t-value
Age	-0.00391***	(0.000586)
Lev	-0.235***	(0.0261)
Cash	0.242***	(0.0557)
Size	0.0343***	(0.00729)
Growth	0.0000667***	(0.0000160)
Far	-0.121***	(0.0227)
Navps	0.000918	(0.000605)
Dt＜4.6634	0.000230	(0.000585)
Dt≥4.6634	-0.00470***	(0.00164)

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

Table.11. Parameter Regression Results of Panel Threshold Model of Digital Transformation on Corporate Performance with Low Human Capital Utilization Efficiency

The parameter regression results in Table.11.show that when the human capital utilization efficiency is low, digital transformation has a significant threshold effect on corporate performance (threshold value 4.6634): after the transformation crosses this threshold, each 1-unit increase in digital transformation leads to a 0.00470-unit decrease in corporate performance. The core reason is the insufficient adaptation between human capital and digital transformation. On the one hand, the deepening of transformation requires employees to have higher digital skills. If the enterprise neglects skill training and fails to develop employees' innovative capabilities, it will lead to the lag of employees' skills. High-efficiency digital tools cannot be fully utilized, resulting in resource waste; on the other hand, the maintenance and upgrading of digital equipment require matching skill support, while low human capital utilization efficiency makes it difficult to convert digital resources into output. Enterprises are prone to falling into a cycle of "input - ineffectiveness - re-input". Even if training is carried out, the cycle may be too long or the conversion rate may be low due to efficiency issues.

Before reaching the threshold value, the promoting effect of digital transformation on corporate performance is not significant. This is because the fixed costs in the early stage of transformation are high, and the low human capital utilization efficiency makes it difficult for digital resources to exert value through human resources, resulting in low short-term marginal returns; at the same time, low efficiency is often accompanied by path dependence and organizational inertia, and the enterprise's operational processes are rigid, making it difficult to quickly adapt to digital needs for reconstruction and update, thereby leading to difficulty in improving performance.

Similarly, this paper uses the same method to test the threshold effect of data with high human capital utilization efficiency, and the threshold regression results are as follows:

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single Threshold	22.01	0.3333	10.4586	12.0510	15.6248

Table.12. Threshold Effect Test Results of Digital Transformation on Corporate Performance with High Human Capital Utilization Efficiency

The regression results in Table.12. show that P = 0.3333, which fails the significance test. When the human capital utilization efficiency is high, the threshold effect of digital transformation on corporate performance is not significant. At this time, employees can complete tasks efficiently, reduce resource waste, and master digital technologies with low training and learning costs, helping enterprises efficiently promote digital transformation and technology absorption. The two are more likely to present a linear promoting relationship, and the positive interaction will delay the arrival of the threshold value where digital transformation shifts from promoting to inhibiting corporate performance.

Therefore, this paper proposes Hypothesis H7: When human capital is high, digital transformation has a significant promoting effect on corporate performance, and constructs a multiple linear regression model to verify it.

$$Roa_{i,t} = \alpha_0 + \alpha_1 Dt_{i,t} + \sum Controls_{i,t} + Year_t + \mu_{i,t} \quad (2)$$

Where *Roa* represents the dependent variable corporate performance, α_0 represents the constant term, Dt represents the independent variable digital transformation, ∑Controls represents various control variables, Year represents the year dummy variable, and μ represents the residual term.

VARIABLES	Roa
Dt	0.0037***
	(3.20)
Age	0.0002

	(0.03)
Growth	0.0050***
	(3.01)
Lev	-0.1444***
	(-12.88)
Far	-0.1209***
	(-9.47)
Navps	0.0030***
	(5.09)
Cash	0.1909***
	(12.63)
Size	0.0118***
	(3.27)
Constant	-0.1847*
	(-1.66)
Observations	4,689
R-squared	0.485

Table.13. Multiple Linear Regression Results of Digital Transformation on Corporate Performance with High Human Capital Utilization Efficiency

The test results in Table.13. show that when the human capital utilization efficiency is high, digital transformation has a significant promoting effect on corporate performance (for each 1-unit increase, performance increases by 0.0037 units). It mainly benefits from the technology absorption and innovation capabilities brought by the efficient use of human resources: employees are highly motivated, adapt to high-intensity work, can quickly master digital tools, reduce training costs, and shorten the transformation return cycle; moreover, they have outstanding creativity and technical literacy, can develop digital systems, expand non-preset application scenarios of tools (such as big data empowering business insights and decision-making), and accelerate the conversion of technology into productivity.

Thus, Hypotheses H6 and H7 are verified.

3.2.2. Ownership Concentration

Ownership concentration refers to the distribution of equity among shareholders and the degree of concentration/decentralization of controlling rights. It is a core dimension of corporate governance, directly affecting the enterprise's strategic decision-making, resource allocation, and performance. Under high concentration, major shareholders can supervise management and ensure strategic stability, but are prone to related transactions; under low concentration, decision-making is more diverse, but high agency costs are likely to cause management myopia. Therefore, the impact of digital transformation on corporate performance varies with different ownership concentration. This paper uses the shareholding ratio of the top ten shareholders to measure ownership concentration, and the higher the ratio, the higher the concentration.

Therefore, this paper proposes Hypothesis H8: The threshold effect of digital transformation on corporate performance varies with different ownership concentration.

Firstly, this paper tests the threshold effect when the ownership concentration is low, and the test results are as follows:

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single Threshold	17.82	0.0200	12.0910	14.3362	19.5777

Table.14. Threshold Effect Test Results of Digital Transformation on Corporate Performance with Low Ownership Concentration

Threshold Value	95% Confidence Interval
4.6634	(4.5218, 4.7362)

Table.15. Threshold Value Estimation of Digital Transformation on Corporate Performance with Low Ownership Concentration

According to the test results in Table.14.and Table.15., there is a single threshold value, and the P-value is 0.0200, which is less than 0.05, significant at the 5% significance level.

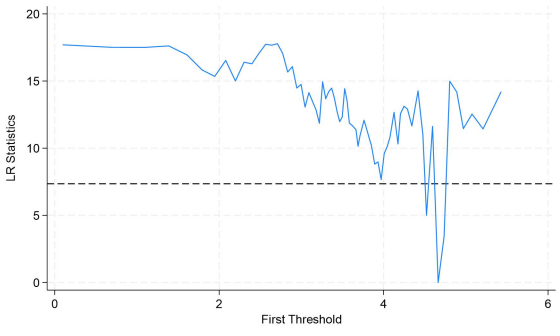

Fig.4. Likelihood Ratio Function Graph with Low Ownership Concentration

By observing Figure 4.4, it can be found that there is a threshold value lower than 7.3523, and the corresponding LR value is exactly 0, proving the existence of this threshold value.

Variable	Regression	t-value

	Coefficient	
Age	-0.00318***	(0.000726)
Lev	-0.245***	(0.0250)
Cash	0.153**	(0.0703)
Size	0.0327**	(0.0134)
Growth	0.0000718***	(0.0000154)
Far	-0.139***	(0.0321)
Navps	0.00284	(0.00178)
Dt＜4.6634	0.00103*	(0.000563)
Dt≥4.6634	-0.00380**	(0.00149)

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

Table.16. Parameter Regression Results of Panel Threshold Model of Digital Transformation on Corporate Performance with Low Ownership Concentration

The regression results in Table.16. show that when the ownership concentration is low, digital transformation has a significant threshold effect on corporate performance (threshold value 4.6634): before the threshold, each 1-unit increase in transformation leads to a 0.00103-unit increase in performance; after the threshold, each 1-unit increase leads to a 0.00380-unit decrease in performance.

The early promotion stems from the absence of complex approval from major shareholders. Management can quickly respond to the market and boldly explore high-risk innovative projects, helping performance growth in the early stage of transformation. The later inhibition is due to: difficulty in maintaining long-term investment in core projects. Minority shareholders are unwilling to bear high transformation costs and are prone to free-riding psychology, leading to insufficient resource adaptation; the diverse demands of shareholders make the transformation strategy vague and inconsistent, resulting in the stagnation of projects. Finally, the inhibitory effect is greater than the promoting effect, which is consistent with the previous conclusion that the performance improvement of digital transformation is slow, and the inhibitory effect caused by internal organizational problems after crossing the threshold is more rapid.

Secondly, the test results of the threshold effect when the ownership concentration is high are as follows:

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single	7.94	0.2167	9.9802	12.6155	16.6464
Threshold					

Table.17. Threshold Effect Test Results of Digital Transformation on Corporate Performance with High Ownership Concentration

The test results in Table.17.show (P = 0.2167, failing the significance test). When the ownership concentration is high, the threshold effect of digital transformation on corporate performance is not significant. The core reason is that enterprises with high concentration have high decision-making efficiency and consistent strategies, which can meet the long-term needs of transformation, and major shareholders can concentrate various resources to promote transformation. Therefore, the two are more likely to present a linear promoting relationship.

Thus, this paper proposes Hypothesis H9: When the ownership concentration is high, digital transformation can play a significant promoting role in corporate performance. Since only the specific values change and the variables do not change, this part still uses model (2) to verify the linear relationship between the two.

VARIABLES	Roa
Dt	0.0021**
	(2.15)
Age	0.0055***
	(3.68)
Growth	0.0070***
	(3.55)
Lev	-0.0971***
	(-12.39)
Far	-0.1039***
	(-10.10)
Navps	0.0021***
	(5.57)
Cash	0.2312***
	(19.11)
Size	0.0094***
	(4.31)
Constant	-0.1965***
	(-3.91)
Observations	6,039
R-squared	0.666

Table.18. Multiple Linear Regression Results of Digital Transformation on Corporate Performance with High Ownership Concentration

The multiple linear regression results in Table.18. show that

for each 1-unit increase in digital transformation, corporate performance increases by 0.0021. When the ownership concentration is high, enterprises can give full play to the promoting role of digital transformation: first, provide institutional guarantee for strategic formulation. Major shareholders can bear the long return cycle and maintain the consistency of transformation strategies; second, major shareholders dominate resource allocation, which can concentrate various resources to support transformation, improve allocation efficiency, and reduce waste; third, reduce organizational inertia, accelerate the restructuring of structure and talents, and adapt to the needs of digital transformation.

Thus, Hypotheses H8 and H9 are verified.

3.3.Mechanism Analysis

3.3.1.Analysis of the Moderating Effect of Financing Constraints

Since most of the indicators used in this paper are positive, while the measurement indicator of financing constraints, the WW index, is negative, for the smooth conduct of the test, the opposite number of the WW index, ww, is used as the threshold variable for regression to test the moderating role of financing constraints in the threshold effect of digital transformation on corporate performance. Accordingly, this paper constructs a threshold effect model, namely model (3), to test the moderating role of financing constraints.

$$Roa=\beta_0+\beta_1 Dt\times 1(ww<A)+\beta_2 Dt\times 1(ww\geq A)+\sum X+\varepsilon \quad (3)$$

Where Roa represents the dependent variable corporate performance, Dt represents the independent variable digital transformation, A represents the single threshold value, 1() represents the indicator function, which takes the value of 1 when the condition in the bracket is satisfied and 0 otherwise. ∑X represents control variables such as Age, Growth, Lev, Far, Cash, Size, and Navps, and ε represents the residual term. At this time, the threshold variable is the ww value. The test results are as follows:

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single Threshold	85.83	0.0000	11.5268	14.2603	17.6395

Table.19. Test Results of the Moderating Effect of Financing Constraints in the Threshold Effect of Digital Transformation on Corporate Performance

Threshold Value	95% Confidence Interval
0.9921	(0.9893, 0.9941)

Table.20. Threshold Value Estimation of the Moderating Effect of Financing Constraints in the Threshold Effect of Digital Transformation on Corporate Performance

According to the test results in Table.19.and Table.20., there is a single threshold value of 0.9921, and the p-value is 0, which is less than 0.01, significant at the 1% significance level.

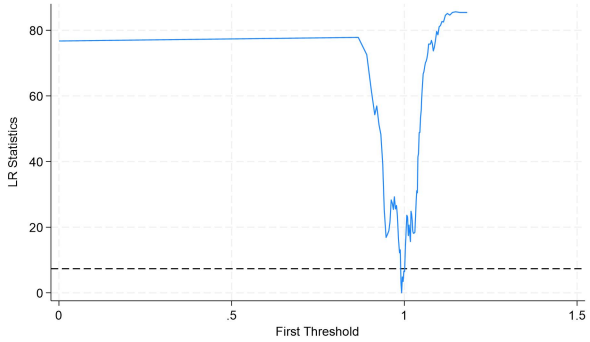

Fig.5. Likelihood Ratio Function Graph of Financing Constraints

It can also be seen from Fig.5.that the critical value of 7.3523 is significantly greater than the single threshold value, and the LR statistic corresponding to this threshold value is 0, so it can be considered that the above threshold value is true and effective.

Variable	Regression Coefficient	t-value
Age	-0.00360***	(0.000441)
Lev	-0.227***	(0.0201)
Cash	0.205***	(0.0465)
Size	0.0274***	(0.00580)
Growth	0.0000707***	(0.0000266)
Far	-0.129***	(0.0162)
Navps	0.00124**	(0.000607)
ww＜0.9921	-0.00142***	(0.000510)
ww≥0.9921	0.00255***	(0.000557)

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

Table.21. Parameter Regression Results of Panel Threshold Model of the Moderating Effect of Financing Constraints

According to the regression results in Table.21., when ww <

0.9921, that is, WW > -0.9921, each 1-unit increase in digital transformation leads to a 0.00142-unit decrease in corporate performance, that is, when the financing constraints faced by the enterprise exceed -0.9921, digital transformation has a significant negative impact on corporate performance. Similarly, when the financing constraint is less than -0.9921, digital transformation has a significant positive impact on corporate performance, and each 1-unit increase in digital transformation leads to a 0.00255-unit increase in corporate performance.

Thus, Hypothesis H2 is verified.

3.3.2 Analysis of the Moderating Effect of Agency Costs

This paper uses the ratio of administrative expenses to operating income to measure the enterprise's agency costs, that is, agency costs = administrative expenses / operating income, denoted by Cr, and uses it as the threshold variable for regression to verify the moderating role of agency costs in the threshold effect of digital transformation on corporate performance. For this purpose, model (4) is established.

$$Roa = \beta_0 + \beta_1 Dt \times 1(Cr < B_1) + \beta_2 Dt \times 1(B_1 \le Cr < B_2) + \beta_3 Dt \times 1(Cr \ge B_2) + \sum X + \varepsilon \quad (4)$$

Where Roa represents the dependent variable corporate performance, Dt represents the independent variable digital transformation, B1 and B2 represent the two threshold values respectively, 1() represents the indicator function, which takes the value of 1 when the condition in the bracket is satisfied and 0 otherwise. ∑X represents control variables such as Age, Growth, Lev, Far, Cash, Size, and Navps, and ε represents the residual term. At this time, the threshold variable is Cr.

Number of Threshold Values	F-statistic	P-value	10% Critical Value	5% Critical Value	1% Critical Value
Single Threshold	137.20	0.0000	15.2565	17.2573	23.9652
Double Threshold	85.43	0.0000	14.7388	17.9438	23.6759

Table.22. Test Results of the Moderating Effect of Agency Costs

Threshold Value	95% Confidence Interval
0.0548	（0.0521,0.0566）
0.1472	（0.1402,0.1520）

Table.23. Threshold Value Estimation Results of Agency Costs

From the test results in Table.22.and Table.23. there is a single threshold value of 0.0548 and a double threshold value of 0.1472, and the P-values are all less than 0.01, significant at the 1% significance level.

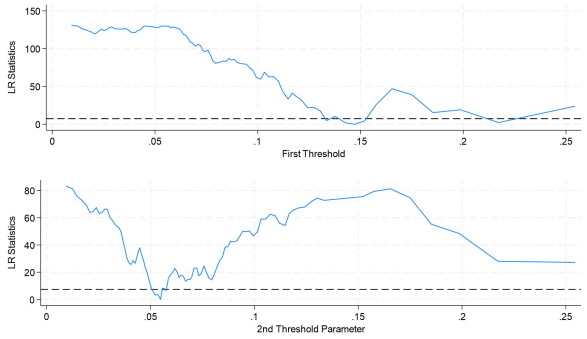

Fig.6. Likelihood Ratio Function Graph of Agency Costs

It can also be clearly seen from Fig.6. that there are threshold values lower than 7.3523, and there are two points where the corresponding LR statistics are exactly 0, thus confirming the existence of double threshold values.

Variable	Regression Coefficient	t-value
Age	-0.00450***	(0.000439)
Lev	-0.225***	(0.0201)
Cash	0.197***	(0.0485)
Size	0.0264***	(0.00550)
Growth	0.0000708***	(0.0000270)
Far	-0.128***	(0.0159)
Navps	0.00140**	(0.000634)
Cr＜0.0548	0.00418***	(0.000598)
0.0548≤ Cr＜0.1472	-0.0000783	(0.000493)
Cr≥0.1472	-0.00758***	(0.00142)

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

Table.24. Parameter Regression Results of Panel Threshold Model of the Moderating Effect of Agency Costs

According to the test results of different intervals in Table.24., when the agency cost is lower than 0.0548, the impact coefficient of digital transformation on corporate performance is 0.00418, which is significant at the 1% significance level, that is, for each 1-unit increase in digital transformation, corporate performance increases by 0.00418 units. When the agency cost is between 0.0548 and 0.1472, the inhibitory effect of digital transformation on corporate performance is not significant. When the agency cost exceeds 0.1472, each 1-unit increase in digital transformation leads to a 0.00758-unit decrease in corporate

performance, and this negative impact is significant at the 1% significance level. That is, before reaching the first threshold value, agency costs strengthen the promoting effect of digital transformation on corporate performance; after reaching the second threshold value, agency costs enhance the inhibitory effect of digital transformation on corporate performance.

Thus, Hypothesis H3 is verified.

3.3.3. Mediating Effect of Organizational Resilience

To test the mediating effect, this paper constructs the following three models and adopts the three-step method for testing.

$$Roa_{i,t} = \alpha_0 + \alpha_1 Dt_{i,t} + \sum Controls_{i,t} + Year_t + Ind_i + \varepsilon_{i,t} \quad (5)$$

$$X_{i,t} = \beta_0 + \beta_1 Dt_{i,t} + \sum Controls_{i,t} + Year_t + \ln d_i + \varepsilon_{i,t} \quad (6)$$

$$Roa_{i,t} = \gamma_0 + \gamma_1 Dt_{i,t} + \gamma_2 X + \sum Controls_{i,t} + Year_t + Ind_i + \varepsilon_{i,t} \quad (7)$$

Where Roa is the dependent variable, Dt is the independent variable, X is the mediating variable, and Controls are the control variables. Let X = Re to test the mediating effect of organizational resilience, and the test results are as follows:

	(1)	(2)	(3)
VARIABLES	Roa	Re	Roa
Dt	0.0007*	-0.0055***	0.0009**
	(1.81)	(-2.63)	(2.31)
Re			0.0102***
			(3.85)
Age	-0.0037***	-0.0168***	-0.0031***
	(-7.53)	(-17.92)	(-7.89)
Lev	-0.2008***	0.0061	-0.1872***
	(-11.74)	(0.13)	(-12.28)
Cash	0.2185***	-0.2902***	0.2697***
	(4.29)	(-5.28)	(11.54)
size	0.0292***	-0.0153	0.0279***
	(4.63)	(-0.95)	(7.61)
Growth	0.0001***	0.0002***	0.0001***
	(3.71)	(3.13)	(3.38)
Far	-0.1357***	0.0929*	-0.1571***
	(-8.08)	(1.85)	(-9.81)
Navps	0.0013*	0.0082*	0.0011**
	(1.95)	(1.89)	(2.08)
Constant	-0.4732***	1.1541***	-0.4614***
	(-3.62)	(3.56)	(-6.03)
Observations	9,631	9,003	9,003
R-squared	0.202	0.040	0.218
Number of ID	1,151	1,144	1,144

Table.25.Mediating Effect of Organizational Resilience

The result of the first column (1) shows that the regression coefficient of Dt is 0.0007, which is significant at the 10% level, indicating that digital transformation has a significant total effect on corporate performance. The result of the second column (2) shows that the regression coefficient of Dt is -0.0055, which is significant at the 1% level, that is, digital transformation will significantly reduce organizational resilience. After adding both Dt and Re, the regression coefficient of organizational resilience (Re) on corporate performance (Roa) is 0.0102, which is significant at the 1% level, indicating that organizational resilience can positively affect corporate performance; at this time, the regression coefficient of Dt on Roa is 0.0009 (t=2.31), which is still significant at the 5% level, indicating that the direct effect of digital transformation on corporate performance still exists. However, overall analysis shows that the total effect of digital transformation on corporate performance (0.0007) is smaller than the direct effect (0.0009), indicating that the mediating effect of organizational resilience at this time is a suppression effect. Digital transformation reduces organizational resilience, thereby reducing its promoting effect on corporate performance.

Thus, Hypothesis H4 is verified.

3.3.4 Mediating Effect of Technological Innovation Input

Based on the above three models (5), (6), and (7), let X = Rd to test the mediating effect of technological innovation input. The test results are as follows:

	(1)	(2)	(3)
VARIABLES	Roa	Rd	Roa
Dt	-0.0228**	0.0210***	-0.0165*
	(-2.38)	(3.51)	(-1.68)
Rd			-0.3006***
			(-3.43)
Age	-0.0028*	0.0033***	-0.0018
	(-1.91)	(3.83)	(-1.15)

Lev	-0.2614***	-0.0203	-0.2675***
	(-5.92)	(-0.86)	(-5.98)
Cash	0.1731***	-0.0699**	0.1521**
	(2.63)	(-2.27)	(2.35)
Size	0.0262**	-0.0068	0.0241**
	(2.20)	(-1.26)	(2.04)
Growth	0.0055***	-0.0003	0.0055***
	(6.33)	(-0.47)	(6.69)
Far	-0.2957***	-0.0404	-0.3078***
	(-3.07)	(-1.08)	(-3.16)
Navps	0.0007	-0.0001	0.0007
	(0.51)	(-0.14)	(0.48)
Constant	-0.2706	0.1988*	-0.2109
	(-1.02)	(1.83)	(-0.80)
Observations	887	887	887
R-squared	0.207	0.120	0.224
Number of ID	211	211	211

Table.26.Mediating Effect of Technological Innovation Input

The results in Column (1) shows the regression coefficient of Digital Transformation (Dt) is -0.0228, significant at the 5% level, indicating Dt exerts a significant negative total effect on corporate performance. Column (2) reveals Dt's coefficient for technological innovation input (Rd) is 0.0210 (1% significance), meaning Dt significantly boosts Rd. With both Dt and Rd included, Column (3) reports Dt's coefficient of -0.0165 (10% significance), confirming its direct effect on corporate performance persists. Overall, the total effect's absolute value surpasses the direct effect's, implying Rd plays a partial mediating role in Dt's inhibitory impact.

Thus, Hypothesis H5 is verified.

4.Research Conclusions and Policy Recommendations

4.1. Research Conclusions

First, the relationship between digital transformation and corporate performance in manufacturing enterprises is not a simple linear one, but exhibits a significant threshold effect of "first promoting and then inhibiting". Before reaching the threshold, the promoting effect of digital transformation on corporate performance is relatively slow; after crossing the threshold, the inhibitory effect becomes more pronounced, reflecting the non-linear adaptation between the depth of transformation and performance.

Second, heterogeneity analysis shows that human capital utilization efficiency and ownership concentration significantly influence this relationship. When human capital utilization efficiency is low, digital transformation exhibits a significant threshold effect (the inhibitory effect after the threshold is prominent, while the promoting effect before the threshold is insignificant); when efficiency is high, the two variables show a linear promoting relationship. When ownership concentration is low, digital transformation has a threshold effect (promoting before the threshold and inhibiting after the threshold); when concentration is high, the two present a linear promoting relationship.

Third, financing constraints and agency costs play moderating roles. When financing constraints are below the threshold, sufficient funds support the adjustment and implementation of transformation strategies, contributing to performance improvement; when exceeding the threshold, capital constraints lead to high trial-and-error costs and delayed transformation adjustments, hindering performance. When agency costs are below the threshold, the interests of management and the enterprise are aligned, resource allocation is efficient, and transformation empowers performance; when exceeding the threshold, interest conflicts cause resource misallocation, exacerbating management problems in the later stage of transformation and inhibiting performance.

Finally, the mediating effect analysis indicates that before the threshold, digital transformation exerts a suppression effect by reducing organizational resilience, weakening its promoting effect on corporate performance; after the threshold, it strengthens the inhibitory effect on performance by increasing technological innovation input, which plays a mediating role.

4.2. Policy Recommendations

(1)Ensure the Supply and Standardized Use of Transformation Funds

First, establish a standardized data system: integrate financial and operational data via ERP/CRM systems, and secure data traceability with blockchain to boost investor trust. Second, expand diversified financing channels: access credit-backed financing through core enterprise supply chain networks, and realize online pledge of receivables and inventory via third-party platforms. Third, cut costs digitally:

adopt cross-border e-commerce export credit insurance and digital currency settlement to mitigate risks. Establish a phased fund supervision mechanism to ensure targeted investment and prevent misappropriation.

(2)Optimize Governance Structure and Stabilize Digital Decision-Making

Optimize the governance environment by: first, setting up a specialized digital transformation decision-making committee (with independent directors and technical directors) and adopting majority voting for major proposals to ensure decision continuity. Second, building a full-process transparent supervision mechanism to track implementation and reduce resource misallocation. Third, developing a risk early-warning system to adjust transformation directions promptly amid market/technological changes.

(3)Strengthen Human Resource Development and Efficient Utilization

First, conduct targeted technical and innovative skill training in the early transformation stage to accelerate digital-to-efficiency conversion. Second, promote cross-departmental collaboration teams to encourage communication and creativity. Third, improve incentive and care mechanisms: align incentives with transformation goals, provide a favorable working environment, and address employee emotional needs to prevent talent loss from rapid organizational changes.

(4)Break Path Dependence on Blind Investment

Review existing innovation paths based on technological trends and market demands, abandoning "experience-based investment" inertia. Rationalize transformation paths, focus on technological innovation input conversion efficiency, and establish a "digital + innovation" collaboration mechanism to break data-R&D barriers. Allocate resources to balance transformation costs and innovation output, leveraging technological innovation to offset short-term transformation pain and release long-term value.

(5)Address the Dilemma of Organizational Resilience

First, build a flexible organizational structure to enhance dynamic resource allocation. Second, establish cross-departmental collaboration platforms to strengthen information sharing and rapid response. Third, cultivate an agile innovation culture: integrate risk response into transformation planning and improve organizational shock resistance through simulation drills, balancing efficiency and flexibility.

REFERENCES

1. Chen, X., Jiang, Y., & Xiong, Y. (2023). Research on the Impact Mechanism and Path of Digital Transformation on Corporate Performance. Reform of Economic System, (02), 112-120.
2. Fu, Y., Xu, Q., & Lin, S. (2021). The Impact of Incumbent Firms' Process Digitalization on Innovation Performance: The Moderating Role of Organizational Inertia. R&D Management, 33(01), 78-89. https://doi.org/10.13581/j.cnki.r d m .2 0202204
3. Zhao, S. J., Yi, L. F., & Lian, Y. L. (2021). Entrepreneurial Leadership, Organizational Resilience, and New Venture Performance. Foreign Economics & Management, 43(03), 42-56. https://doi.org/10.16538/j.cnki.fem.20201229.101
4. Jiang, L., Ling, Y. P., Zhang, J. C., et al. (2022). How Does Digital Transformation Affect Corporate Resilience? From the Perspective of Ambidextrous Innovation. Technology Economics, 41(01), 1-11.
5. Fan, H. J., & Pan, N. N. (2024). Digital Transformation, Agile Responsiveness, and Corporate Resilience. Economic Management, 46(07), 36 -54. https://doi.or g/10.19616/j.cnki.bmj.2024.07.003
6. Dai, X. Y., & Cheng, L. W. (2013). A Threshold Effect Study on the Impact of R&D Investment Intensity on Corporate Performance. Studies in Science of Science, 31(11), 1708-1716+1735. https://doi.org/10.16192/j.cnki.1003-2053.2013.11.015
7. Han, X. F., & Dong, M. F. (2018). The Threshold Effect of R&D Investment on Corporate Performance. Journal of Beijing Institute of Technology (Social Sciences Edition), 20(02), 95-101+116. https://doi.org/10.15918/j.jbitss1009-3370.2018.1185