Research on the Impact of Digital Transformation on Financial Performance of Chinese Listed Companies

Guangqiang Han[1], Shixin Tang[2,*]

{2148500@qq.com[1], 2442990143@qq.com[2,*]}

The College of Economics Bohai University, Jinzhou, Liaoning, China

Abstract: Digital transformation, as a crucial part of enterprise renewal and transformation, is also a crucial step for enterprises to enhance their innovation capabilities and achieve high-quality development. The article selects the data of Chinese listed companies' Shanghai and Shenzhen A-shares from 2012 to 2022 as the sample, and adds intermediary variables such as cost, scale, and research and development to analyze the relevant impacts. Benchmark analysis shows that digital transformation still has a negative impact on the financial performance of enterprises, resulting in poor financial performance. Through the analysis of intermediary variables, it can be concluded that increasing the scale, investment, and cost of research and development still has a negative impact on the financial performance of enterprises, but it can reduce the negative impact of digital transformation on financial performance. The results of the argument were also verified in the robustness test. The results indicate that improving enterprise R&D capabilities, increasing R&D intensity, and increasing the degree of digital transformation are beneficial for promoting enterprise development and improving the financial situation in the long run.

Keywords: Digital transformation; Financial performance; R&D; Mediating effects

1 Introduction

In recent years, society has entered a period of rapid development, and digitalization has gradually become a key link for enterprises to develop rapidly. However, there are still many traditional and emerging enterprises that have not adapted to digitalization and urgently need to transform to avoid being eliminated by social development. How to enhance R&D innovation capabilities, enhance the technological level of enterprises, carry out digital transformation, and assess the degree of digital transformation requires relevant performance evaluation. Financial performance has gradually become a key indicator for evaluating the degree of digital transformation. As an emerging indicator, there is relatively little research linking digitization to financial performance, so it's necessary to study these key indicators and establish models for empirical research. The innovation of this article is to explore the relationship between digital transformation and financial performance using multiple intermediary variables, and to conduct multiple verifications of the conclusions drawn. A panel data model is used for research, and relevant data is truncated to exclude relevant interfering factors. The empirical results are more accurate. However, due to the limited number of independent variables and dependent variables selected in this article, it's difficult to represent the overall data, resulting in insufficient representativeness and certain limitations.

2 Literature Review

In the past decade, the technology development of enterprises has been rapid, but the impact on digital transformation and financial performance has not been fully studied. This article explores relevant Chinese and foreign literature in recent years, studies relevant models and practices, and explores the mutual influence between key indicators.

Gok and Peker (2017) divide performance into two aspects: financial performance and market performance, and propose the concept of innovation performance to explore the relationship between innovation and enterprise performance. This article also emphasizes the importance of R&D innovation and explores its relationship with financial performance. The article proposes that innovation has a significant negative relationship with a company's financial performance, which is consistent with the viewpoint of this article [1]. Jackson (2021) explored the importance of innovation and talent in digital transformation, and conducted organizational model construction and practice. So this article uses the scale of R&D talents as an intermediary variable [2]. Kouspos (2022) using a panel data model, explore the relationship between technological innovation and financial performance, and propose that innovation is beneficial for improving the financial situation of enterprises. This article draws on the panel data model to study the relationship between variables[3]. Ancillo (2023) emphasize the importance of research and development and explore its key role in innovation and digital transformation. This article draws inspiration from this research method and uses R&D as a mediating variable in the model to explore the mediating effects generated by digital transformation[4].Yang Huixian (2020) explored the impact of innovation on financial performance of energy enterprises, emphasizing the importance of innovative technology, and verifying the necessity of selecting innovation as an intermediary variable in this article[5]. Bai Fuping(2022) proposed a multiple mediation effect model to explore the impact of various factors generated by digital transformation on financial performance. This article selects three possible mediating variables to explore the mutual influence between variables[6]. Liang Linna (2022) explore the impact of digitalization on enterprise performance, establish a threshold model, and ultimately draw the conclusion of the U-shaped effect. The conclusion of this article has reference significance, understanding the impact process of relevant variables [7]. Jiang Xuesong (2023) proposed a perspective on digital transformation to explore the impact of intelligent finance on financial performance. So this article takes digital transformation as the dependent variable[8].

3. Research Design

3.1 Data Processing

The software used to process data in this article mainly includes Excel, Stata18, and Python. The data sources are CNKI Resources Network and CSMAR database. The main method is to obtain relevant data from the database and company reports through Python, and use Stata18 and Excel software for data cleaning, including merging variable data, removing missing values, logarithmic processing of numerical values, and ratio processing. Perform tail reduction on all data, removing 1% of abnormal data from the beginning and end, making the data closer to the true level. Selecting relevant data from the Shanghai and Shenzhen A-share markets, excluding irrelevant factors, we ultimately obtained 24378 samples. Descriptive analysis, correlation

analysis, fixed effects regression analysis, and Hausman test were performed on the sample data to determine the use of fixed effects models, as well as multicollinearity and robustness tests.

3.2 Variable Definition

1) Explanatory variable: Digital Transformation(digital). Using Python to crawl the financial reports of listed companies in the Shanghai and Shenzhen A-shares from 2012 to 2022 in the CSMAR database, the frequency of words related to the degree of digital transformation of listed companies is statistically analyzed, mainly including five aspects: artificial intelligence technology, blockchain technology, cloud computing technology, big data technology, and digital technology application. Then count the data related to the frequency of five groups of words, sum the analysis results, add one to the final sum, take the logarithm, and divide by 100 as the data for digital transformation.2) Explained Variable: ROA. Obtained by dividing net profit by net assets. For the selection of representative data on financial performance, this article compared ROE, Tobin Q, and ROA, and used Stata18 regression to determine the goodness of fit and significance. For the fitting degree of the model and the representativeness of financial performance, this article selects ROA as the representative variable of financial performance.3) Control variables: Age and Size (age size). The age and size of a company must be controlled due to their varying size and establishment time. The size of a company is obtained by taking the logarithm of its market value. Financial leverage ratio (ri), obtained by dividing EBIT by total profit before tax, which controls the debt risk and financial pressure of a company, without considering the situation of bankruptcy and restructuring of the company. Tobin Q（tobinq）, which controls the growth ability of a company, must be controlled due to its significant impact on market performance, instability, and controversy. Current asset turnover rate (catr). Calculated by dividing operating revenue by the number of turnover of current assets. It is necessary to control the operational capacity, liquidity, and liquidity of the enterprise.

4) Intermediary variable*: ①R&D(rd). R&D intensity is the core of a company's digital transformation, so it is chosen as an intermediary variable. We use the company's R&D investment as the representative quantity of the company's R&D intensity. The data results are obtained by dividing R&D expenditure by operating income through Excel, and relevant data is collected through Stata18 for cleaning and regression. ②Cost. Cost is an important factor affecting the financial performance of enterprises, and controlling costs is crucial for evaluating financial performance. Cost is also one of the urgent issues to be addressed in digital transformation. We use the operating cost rate of a company as a representative data, and calculate it as the total operating cost of the company divided by the total operating revenue of the company. ③Num. This article specifically discusses digitalization, and R&D personnel are a key part of the R&D process. Therefore, the scale data of enterprise R&D personnel is represented as the R&D scale data of the enterprise, and the scale of the enterprise is controlled to provide guarantees for expanding R&D and reducing risks. The specific calculation is the proportion of R&D personnel in the total company personnel, and relevant factors are adjusted through Stata18 to eliminate interference from unrelated factors. Digital transformation is closely related to the innovation and research and development of enterprises. This article selects three sets of intermediary variables related to enterprise research and development. At the same time, all three sets of variables are ratio data, avoiding the trouble of taking logarithms.

3.3 Assumption Establishment

Due to the fact that digital transformation is still in its early stages in China, some traditional listed companies are facing the stage of enterprise transformation, technological updates, and R&D investment, as well as the installation and updating of various digital equipment, which will bring great cost pressure to enterprises. Enterprises with a short establishment period do not have sufficient funds for transformation and transformation, and do not have sufficient capabilities for digital transformation. It can be inferred that, at present, the digital transformation of enterprises still has a negative impact on their financial performance. What's more, it's necessary to consider the mediating effects of digital transformation on the cost, scale, and research and development of enterprise financial performance, propose mediating effect hypotheses, and conduct empirical analysis to verify these hypotheses:TH1) Digital transformation can directly impact a company's financial performance.TH2)Will increase its investment in R&D, which means increasing the proportion of R&D expenses and reducing the negative impact of digital transformation on company's financial performance.TH3)Enhances the scale of R&D personnel and reduces the negative impact of digital transformation on corporate financial performance.TH4)Increases cost investment, which means increasing the operating cost ratio to address the negative impact of digital transformation on corporate financial performance.

3.4 Model Establishment

The data in this article is mainly based on the Shanghai and Shenzhen A-share markets, not only because of their long established history, large scale, and mature capital operations, but also because they include a large number of large enterprises, comprehensive financial data, and a high degree of digital transformation, making them representative. It can eliminate the influence of irrelevant small factors and help improve the representativeness and accuracy of the model. This article selects data from the stock market from 2012 to 2022, excluding data from the Beijing Stock Exchange, ST, and companies listed in the past year. The report selects consolidated report data of the company, and the overall method is used to calculate the relevant data, resulting in 24378 samples. R&D innovation is the core of enterprise digital transformation, and the cost pressure and R&D investment pressure brought by digital transformation to enterprises are enormous, which may have a significant impact on the evaluation of related financial performance of enterprises. Therefore, this article takes the R&D, scale, and cost of enterprises as intermediary variables and adopts a step-by-step approach to explore the relevant impact of intermediary effects. Formula (1) explores the direct impact of digitalization on financial performance. Formulas (2), (3), and (4) perform correlation regression with cost, R&D, and scale as the dependent variables. X_{it} includes $Cost_{it}$, $R\&D_{it}$ and Num_{it}. $Control_{it}$ include age, size, ri, toobinq, catr related control variables, and setting a fixed correlation model with annual dummy variables, where i represents an individual and t represents time. Formula as follows:

$$ROA_{it}=\alpha_0+\alpha_1 Digital_{it}+\alpha_2 Control_{it}+\sum Year+\sum Industry+\varepsilon_{it} \tag{1}$$

$$Cost_{it}=\gamma_0+\gamma_1 Digital_{it}+\gamma_2 Control_{it}+\sum Year+\sum Industry+\varepsilon_{it} \tag{2}$$

$$R\&D_{it}=\theta_0+\theta_1 Digital_{it}+\theta_2 Control_{it}+\sum Year+\sum Industry+\varepsilon_{it} \tag{3}$$

$$Num_{it}=\beta_0+\beta_1 Digital_{it}+\beta_2 Control_{it}+\sum Year+\sum Industry+\varepsilon_{it} \tag{4}$$

$$ROA_{it}=\varphi_0+\varphi_1 Digital_{it}+\varphi_2 Control_{it}+\delta X_{it}+\sum Year+\sum Industry+\varepsilon_{it} \qquad (5)$$

4. Empirical analysis

4.1 Descriptive analysis

This article selected 24378 data, and the results of the descriptive analysis of the relevant variables from 2012 to 2022 are shown in the figure. From the table 1, except for the age variable, the standard deviation of each variable is not high, indicating that the dispersion of the average value of the data is not high and relatively stable. The average size of the enterprise is 22.35, and the difference between the maximum and minimum values is not significant, indicating that the scale of the studied enterprises is relatively large. The average age of the enterprise is 10.72, indicating that the duration of the enterprise is relatively long, with a minimum value of 2, indicating that the digital transformation of newly established and developing enterprises is still relatively difficult.

Table 1. Descriptive analysis results

Variable	Obs	Mean	Std.dev.	Min	Max
lndigital	24,378	0.00678	0.00619	0	0.0224
roa	24,378	0.0471	0.0697	-0.259	0.237
num	24,378	0.129	0.135	0	0.669
rd	24,378	0.0477	0.0492	0	0.284
cost	24,378	0.942	0.140	0.585	1.601
age	24,378	10.72	7.202	2	28
size	24,378	22.35	1.276	20.11	26.38
ri	24,378	0.423	0.195	0.0624	0.881
tobinq	24,378	2.075	1.313	0.835	8.379
catr	24,378	1.197	0.843	0.202	5.169

4.2 Correlation analysis

According to formula (1), this article conducts a preliminary analysis of the correlation between the control variable and the explanatory and dependent variables in the variables. From the table 2, the correlation coefficient between ROA and lndigital is -0.061, which is significant at the 1% level. It's preliminarily proven that hypothesis 1, lndigital can directly affect ROA, and there is a negative correlation. Compared with other control variables, it's significant at the 1% level, indicating that the selection of control variables is more in line with the model. The correlation coefficients of each variable, whether positive or negative, are less than 0.5, indicating that the model is not affected by multicollinearity.

4.3 Benchmark regression analysis

For the random and fixed regression results of xtreg, Hansuann test is conducted to determine fixed effects panel regression, and both time fixed effects and individual fixed effects are added for double fixation. Finally, the panel data was regressed and passed the F-test. The main regression is three times, (1) is the independent variable and the dependent variable, (2) is the independent variable plus the control variables of enterprise size and age, and (3) is the regression of all control variables including financial indicators of the enterprise.

Table 2. Fixed panel regression analysis

	(1) roa	(2) roa	(3) roa
lndigital	-0.887***(-9.52)	-0.824***(-8.79)	-1.067***(-12.37)
age		-0.00230***(-22.87)	-0.00204***(-22.37)
size		0.0104***(17.15)	0.0230***(38.73)
ri			-0.159***(-51.78)
tobinq			0.00949***(26.55)
catr			0.0155***(22.95)
cons	0.0534***(50.24)	-0.155***(-11.99)	-0.409***(-32.38)
N	24378	24378	24378

The result of column (3) is obtained from formula (1). Through the regression results of the table 2, columns (1), (2), and (3) all indicate a significant negative correlation between financial performance and digital transformation at the 1% level, confirming hypothesis 1. At the same time, through columns (2) and (3), it can be seen that the size of the enterprise, Tobin Q, and current asset turnover are significantly positively correlated with ROA at the 1% level, which can promote the improvement of financial performance. The age and financial leverage ratio of the enterprise are significantly negatively correlated, indicating that the risk and age of the enterprise will lead to a decrease in financial performance. After adding control variables, the regression coefficients of ROA and lndigital of the enterprise showed significant changes, indicating that these variables must be controlled. Avoid interference from unrelated factors, and verifying TH 1.

4.4 Analysis of multiple mediating variables

Considering the mediating effect between the independent variable and the dependent variable, this article introduces three mediating variables: lndigital, age, and size, and uses stepwise regression method to control for the control variable and explore the influence of the mediating variable.

Table3. Regression results based on three mediating variables

	(1) roa	(2) num	(3) cost	(4) rd	(5) roa
lndigital	-1.067***(-12.37)	7.122***(46.60)	0.969***(5.43)	0.858***(18.64)	-0.393***(-6.04)
num					-0.0230***(-7.59)
rd					-0.0535***(-5.55)
cost					-0.339***(-137.73)
controls	yes	yes	yes	yes	yes
cons	-0.409***(-32.38)	-0.278***(-11.35)	1.832***(67.49)	0.133***(17.14)	0.215***(22.50)
N	24378	24378	24378	24378	24378

According to formula (1)-(5), form the table 3, divided into five groups. Group (1) is the direct impact of ROA and lndigital, Group (2), (3), and (4) are the mediating variables used as the dependent variables for model regression, and Group (5) is the model regression for all variables. Research has shown that there is a significant correlation between various variables, and there is a significant positive correlation between digital transformation and intermediary variables at the 1% level. Digitalization can enhance the intensity and scale of R&D, but it will increase cost pressure and have a negative impact on corporate financial performance. However, with the addition of intermediary variables, the regression coefficients of ROA and lndigital of the

enterprise changed from -1.067 to -0.393, and the absolute value decreased, indicating a smaller negative impact. It can be seen that increasing R&D scale and costs, reducing the negative impact of digital transformation on the financial performance of the enterprise, and verifying TH 2, 3, and 4.

4.5 Robustness testing

1)Increase the tail reduction range. The previous text has already conducted a 1% tail reduction on the data. In order to avoid incomplete reduction of interference items, the tail reduction range has been adjusted to 4% before and after, to eliminate more interference factors. 2) reduce the research year. Due to the poor timeliness of the initial data and incomplete data from the last year, the data from the first two years and the last year were deleted, while the data from the remaining years was retained to avoid the impact of time factors on the relevant analysis and eliminate interference factors. 3)Replace the dependent variable. The selection of explanatory variables has already been introduced earlier. As Tobin Q mainly represents market performance, this article selects Return on Equity (ROE) as the substitute object.

Table 4. Robustness test results of three methods

	(1) roa	(2) roa	(3) roe
lndigital	-0.144***(-3.00)	-0.243***(-3.17)	-0.388**(-2.26)
num	-0.0153***(-6.34)	-0.0198***(-5.22)	-0.0514***(-6.32)
cost	-0.377***(-158.26)	-0.0478***(-4.00)	-0.711***(-107.03)
rd	-0.0767***(-8.53)	-0.339***(-116.08)	-0.0243(-0.95)
controls	yes	yes	yes
cons	0.311***(39.15)	0.204***(17.96)	0.307***(12.29)
N	24378	18018	24378

From the table 4, it can be seen that changing the relevant data did not affect the correlation and significance of the variables. Except for the third group, which was significant at the 5% level, the other two groups were significant at the 1% level and did not change the direction of the influence of the intermediary variable. Consistent with the previous argument, the conclusion that digital transformation has a certain negative impact on financial performance is robust, and the conclusion that intermediary variables play a certain mediating effect is robust.

5. Research Conclusion and Suggestions

This article is based on existing literature and models, and conducts empirical research by establishing a model. Through benchmark research, the impact of digital transformation on financial performance of enterprises is still negative, and most enterprises are still in this stage. By adding intermediary variables, it can be seen that increasing R&D investment and scale, as well as increasing cost investment, has a negative impact on financial performance. However, it can greatly alleviate the negative impact of digital transformation on corporate financial performance and alleviate financial pressure on enterprises. At the same time, this article conducted relevant tests to verify the correctness of the above conclusions. The following suggestions are proposed in this article:

1)enterprises should continue to prioritize R&D innovation, increase investment in R&D, and continuously increase cost scale. Although for now, increasing investment costs is not conducive

to good financial performance. However, currently it has the ability to alleviate the negative impact of digital transformation, which is beneficial for improving financial performance in the long run. 2)actively respond to national policies and continuously promote digital transformation. Compared to the current situation, traditional and emerging enterprises face difficulties in transformation, and the costs they need to bear and pay are relatively high. However, in the information age, if they are not transformed in a timely manner, they may be eliminated by the times. 3) financial performance cannot be the only criterion for evaluating the good development of enterprises. We should have a long-term perspective, not limited to improving current good financial performance, or only seeing the short-term negative impact of digital transformation on financial performance. Instead, we should utilize our own advantages, actively enhance innovation and research capabilities, and respond to long-term challenges. 4) make digitization an important part of enterprise performance evaluation. The market and financial performance of an enterprise cannot be solely used as evaluation criteria for enterprise performance, but should be comprehensively judged based on the enterprise's research and innovation capabilities and degree of digital transformation.

References

[1]   Gok O, Peker S. Understanding the links among innovation performance, market performance and financial performance[J]. Review of Managerial Science, 2017, 11(3):605-631.

[2]   Jackson N C, Dunn-Jensen L M. Leadership succession planning for today's digital transformation economy: Key factors to build for competency and innovation[J]. Business Horizons, 2021, 64.

[3]   Kouspos A A, Panayides P M, Tsouknidis D A. The relationship between technical innovation and financial performance in shipping firms[J]. 2022.

[4]   Ancillo A D L, Gavrila S G. The Impact of R&D on Entrepreneurship, Innovation, Digitization and Digital transformation[J]. Journal of business research, 2023.

[5]   Yang Huixian, Zhang Weihan. The Impact of Technological Innovation Capability of Energy Enterprises on Financial Performance: A Study on the Threshold Effect Based on Enterprise Scale [J]. Technology Economy, 2020,39 (08): 1-9+34.

[6]   Bai Fuping, Liu Donghui, Dong Kaiyun. How Digital Transformation Affects Financial Performance of Enterprises: An Analysis of Multiple Intermediary Effects Based on Structural Equations [J]. East China Economic Management, 2022,36 (09): 75-87.

[7]   Liang Linna, Zhang Guoqiang, Li Hao. Research on the Economic Effects of Enterprise Digital Transformation - Analysis Based on Market Performance and Financial Performance [J]. Modern Management Science, 2022 (05): 146-155.

[8]   Jiang Xuesong, Wang Rui, Guan Lingyu. The impact of intelligent finance on financial performance from the perspective of digital transformation [J/OL]. Friends of Accounting, 2023 (20): 44-51.