Effect of Digital Transformation on Enterprise Performance: Evidence from China

Yan Peng

e-mail: pengyan@scujj.edu.cn

School of Digital Economics, Sichuan University Jinjiang College, Sichuan 620860, China

Abstract: This paper uses the text analysis method to measure the level of enterprise digital transformation, and the data of China's A-share listed enterprises from 2008 to 2020 to study the impact of digital transformation on enterprise performance. The two main findings are: (1) Digital transformation may directly enhance enterprise performance; (2) Digital transformation indirectly improves enterprise performance by promoting innovation and optimizing costs. Lastly, the article offers some policy recommendations for enterprise digital transformation.

Keywords: Digital transformation, Enterprise performance, Enterprise innovation, Cost optimization

1 Introduction

The widespread use of the Internet and ongoing technological advancements have made the digital economy a new engine for world economic growth. Globally, governments have released plans for digital development and have actively pushed the process of digital transformation at the national strategic level. For example, the United States issued the Digital Economy Agenda and Germany proposed “the Digital Strategy 2025”. To achieve high-quality development and expedite the creation of a new development pattern, the report of the Party's 20th National Congress recommended that businesses actively support the adoption of a digital transformation strategy, prioritize improving corporate performance over other tasks, and encourage the full integration of the real economy and the digital economy. However, according to the 2022 Accenture China Digital Transformation Index, as of the end of 2022, only 17% of enterprises undergoing digital transformation have achieved significant results, and most Chinese enterprises still only focus on a single business transformation, with insufficient understanding of digital transformation and weak transformation. Meanwhile, the performance of Chinese companies in key digital capabilities is uneven. Therefore, it is imperative to clarify the effect and path of digital transformation on enterprise performance, and accelerate the effectiveness of enterprise digital transformation.

There are three main views on the effect of digital transformation on enterprise performance. Firstly, digital transformation can revitalize enterprise resources and positively affect enterprise performance (Nwankpa, J. K., Datta, P. 2017[12]). Digital transformation positively impacts company performance through improved customer experience and technological innovation (Masoud， R., Basahel, S. 2023[11]). Secondly, digital transformation will impede the improvement of manufacturing companies' financial performance (Bai, F.P., et al. 2022[1]). Ekata (2012[3])

MSIEID 2023, December 08-10, Guangzhou, People's Republic of China

DOI 10.4108/eai.8-12-2023.2344747

investigated this relationship with a Nigerian bank and discovered that the "IT paradox" is a real phenomenon. Thirdly, digital technology has little to no effect on businesses' overall performance (Li, M., Jia, S. 2018[9]). There are differences in literature conclusions, considering that there are variations in the digital transformation measuring standards, and the effect of digital transformation on enterprise performance is affected by industry categories, internal characteristics of enterprises, and other factors.

Most existing studies quantify digital transformation using questionnaire surveys or subjective measures and focus on the connection between enterprise performance and digital transformation, with little research examining the role that enterprise innovation plays as a mediating factor. Therefore, the following is where this paper innovates: Initially, the text mining approach is used to measure the digital transformation, which serves as a method reference for future quantitative studies on digital transformation. Secondly, the effect of the digital transformation intermediary path on enterprise performance is examined from the standpoint of corporate innovation and cost. Thirdly, the paper concludes that digital transformation can eventually enhance firm performance based on theoretical analysis and uses data of China's A-share listed companies from 2008 to 2020 to conduct an empirical test. As China is the second-largest country with the fastest-growing digital economy, the study of China's sample has implications for other countries.

2 Theoretical analysis and research hypothesis

This paper holds that corporate digital transformation is a crucial component in the growth of the digital economy, and should play a positive role in enterprise performance. Digital transformation will change the operation mode of traditional industries (Zhang, Z.G., et al. 2022[15]), improve the productivity and competitiveness of enterprises (Llopis-Albert, C., et al. 2021[7]), and promote the development of value activities. By integrating digital strategy into organizational culture, firms can expect improved performance (Martínez-Caro, E., et al. 2020[10]).

Firstly, digital transformation can improve an organization's capacity for innovation (Galindo-Martín, M., et al. 2019[4]). As a type of change based on cutting-edge technology, digital transformation has played a driving role in technological innovation. Digital transformation makes enterprises more sensitive to the perception of cutting-edge technologies (Briel, F. V., et al. 2018[2]).

Secondly, enterprise R&D, production, management, governance, and other costs can all be successfully decreased by digital transformation (Qi, H.J., et al. 2020[13]). By using digital technology, senior management of businesses may instantly access production data at the local level and operation data from different departments at the middle level. This lowers management costs, which in turn lowers organization agency costs (Liu, Z., et al. 2020[8]). As a result, the text proposes the following hypothesis:

H1: Digital transformation can improve enterprise performance.

H2: Digital transformation can indirectly promote the improvement of enterprise performance by improving the innovation capability of enterprises.

H3: Digital transformation can indirectly promote the improvement of enterprise performance by reducing enterprise costs.

3 Methodology Materials

3.1 Model

Based on the above content, to test the effect of enterprise digital transformation on enterprise performance, the following regression model is constructed:

$$ROA_{it} = \beta_0 + \beta_1 Dgt_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

The stepwise regression method was used to construct models (2) - (7) based on model (1).

$$ROA_{it} = \beta_0 + \beta_1 Dgt_{it} + \beta_2 lev_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$$ROA_{it} = \beta_0 + \beta_1 Dgt_{it} + \beta_2 lev_{it} + \beta_3 ppe_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (3)$$

$$ROA_{it} = \beta_0 + \beta_1 Dgt_{it} + \beta_2 lev_{it} + \beta_3 ppe_{it} + \beta_4 cash_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (4)$$

$$ROA_{it} = \beta_0 + \beta_1 Dgt_{it} + \beta_2 lev_{it} + \beta_3 ppe_{it} + \beta_4 cash_{it} + \beta_5 board_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (5)$$

$$ROA_{it} = \beta_0 + \beta_1 Dgt_{it} + \beta_2 lev_{it} + \beta_3 ppe_{it} + \beta_4 cash_{it} + \beta_5 board_{it} + \beta_6 dual_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (6)$$

$$ROA_{it} = \beta_0 + \beta_1 Dgt_{it} + \beta_2 lev_{it} + \beta_3 ppe_{it} + \beta_4 cash_{it} + \beta_5 board_{it} + \beta_6 dual_{it} + \beta_7 age_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (7)$$

Where ROA, represents enterprise performance, Dgt represents the degree of enterprise digital transformation, lev, ppe, cash, board, dual, and age indicate asset-liability ratio, the proportion of fixed assets, cash level, number of directors, duality, and enterprise age, μ indicates the fixed effect of the enterprise, γ indicates the fixed effect of the year, and ε is a random term. The standard errors are adjusted by clustering at the enterprise level to reduce the errors caused by the model factors as much as possible.

To test the mediating effect, the stepwise regression method was used to construct models (8) - (11) based on model (7). If α_1 and φ_2 are significant, $\alpha_1 * \varphi_2$ is the indirect effect of the intermediary variable.

$$innov_{it} = \alpha_0 + \alpha_1 Dgt_{it} + \alpha_2 Controls_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (8)$$

$$ROA_{it} = \varphi_0 + \varphi_1 Dgt_{it} + \varphi_2 innov_{it} + \varphi_3 Controls_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (9)$$

$$cost_{it} = \alpha_0 + \alpha_1 Dgt_{it} + \alpha_2 Controls_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (10)$$

$$ROA_{it} = \varphi_0 + \varphi_1 Dgt_{it} + \varphi_2 cost_{it} + \varphi_3 Controls_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (11)$$

3.2 Variables

Enterprise performance (ROA). This paper selects Return on Assets (ROA) as a financial indicator to measure enterprise performance.

Enterprise digital transformation (Dgt). Refer to the relevant keywords (Wu, F., et al 2021[14]), which are artificial intelligence, blockchain, cloud computing, big data, and digital technology

applications. According to the word spectrum, use Python to capture the keywords frequency in the annual reports of each company from 2008 to 2020, and then manually check the selected keywords to remove invalid digital keywords, and finally obtain the word frequency number of relevant keywords. In this paper, the word frequency of five categories is summed and the degree of digital transformation is measured by logarithmic processing.

Mediating variable. Compared to the number of patents awarded, the number of patent applications is more closely aligned with the actual time of innovation output and can accurately represent the degree of innovation (Hall, B. H., et al. 1984[5]). Therefore, enterprise innovation (innov) is measured by the natural logarithm of the total number of patent applications of firms +1. The Cost of a business (cost) is measured as the ratio of operating costs to revenue.

Control variable. Asset-liability ratio (lev) is measured as the ratio of liabilities to assets. The proportion of fixed assets (ppe) is measured as the ratio of fixed assets to total assets. Cash level (cash) is defined as the ratio of net cash from operating activities to total assets. Board size (board) is measured by the number of the Number of directors. Dual function (dual) is measured in this way, the value is 1 if the general manager and the chairman are the same person, otherwise, it is 0. Enterprise age (age) is defined as the years of establishment of the enterprise.

3.3 Data

Research samples are selected from China's A-share listed firms from 2008 to 2020. The CNRDS database provided the number of patent applications submitted by businesses, whereas the CSMAR database provided additional information. The sample processing process excludes companies with only one and two years of complete data; and eliminates major variable data missing companies. Thus, 35647 valid sample observations were obtained, involving 5,299 listed companies, and all continuous variables were winsorized at 1% and 99% to eliminate the influence of extreme values. The descriptive statistical table of main variables is shown in Table 1.

Table 1. Descriptive statistics of main variables

Variables	Obs	Mean	SD	Min	Median	Max
ROA	35647	0.035	0.074	-0.356	0.037	0.220
Dgt	35647	2.635	1.267	0.000	2.565	6.909
innov	35647	2.328	1.791	0.000	2.485	6.711
cost	35647	0.715	0.235	-2.764	0.744	25.501
lev	35647	0.375	0.246	0.000	0.384	0.890
ppe	35647	0.216	0.165	0.001	0.181	0.711
cash	35647	0.170	0.140	0.006	0.128	0.687
board	35647	9.333	2.292	0.000	9.000	17.000
dual	35647	0.275	0.446	0.000	0.000	1.000
age	35647	10.684	7.330	0.000	10.000	27.000

4 Empirical results

4.1 Analysis of Basic Estimation Results

In model (1)-(7) in Table 2, the regression coefficient of digital transformation (Dgt) is all significant at a 1% level, indicating that digital transformation can significantly improve enterprise performance under the premise of controlling other variables.

Table 2. Regression results of enterprise digital transformation on enterprise performance

Variables	(1) ROA	(2) ROA	(3) ROA	(4) ROA	(5) ROA	(6) ROA	(7) ROA
Dgt	0.0022***	0.0034***	0.0025***	0.0030***	0.0031***	0.0031***	0.0031***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
lev		-0.0621***	-0.0598***	-0.0496***	-0.0496***	-0.0496***	-0.0498***
		(0.0037)	(0.0036)	(0.0037)	(0.0037)	(0.0037)	(0.0037)
ppe			-0.0969***	-0.0718***	-0.0721***	-0.0721***	-0.0722***
			(0.0084)	(0.0085)	(0.0085)	(0.0085)	(0.0085)
cash				0.0724***	0.0723***	0.0723***	0.0724***
				(0.0058)	(0.0058)	(0.0058)	(0.0058)
board					-0.0006**	-0.0006**	-0.0006**
					(0.0003)	(0.0003)	(0.0003)
dual						0.0002	0.0002
						(0.0017)	(0.0018)
age							0.0048*
							(0.0027)
Constant	0.0327***	0.0511***	0.0769***	0.0528***	0.0585***	0.0584***	0.0407***
	(0.0025)	(0.0028)	(0.0033)	(0.0040)	(0.0049)	(0.0049)	(0.0109)
n	35,647	35,647	35,647	35,647	35,647	35,647	35,647
R^2	0.0473	0.0750	0.0898	0.1005	0.1007	0.1007	0.1009

Notes: (a):***, **and *denote significance at the 1%, 5% and 10% levels, respectively. (b): Standard errors are presented in parentheses.

In addition, this paper also adopts the robustness test in the following ways: Firstly, lnROA is measured by the log of ROA, which replaces ROA as the explained variable, as shown in model (1) in Table 3; Secondly, quantitative indicators are used for digital transformation indicators. Taking the practice of the reference (Liu, F., Tian, G.L. 2019[6]), the digital level of enterprises is represented by the net amount of ICT hardware plus ICT software divided by the total assets, and the natural logarithm (lndgt) is added by 1 to replace Dgt as the explanatory variable, as shown in model (2). Thirdly, change the sample scope and set the enterprise type to state-owned enterprise, as shown in model (3). The test results were significant. Hypothesis H1 confirmed.

Table 3. Regression results of the robustness test

Variables	(1) lnROA	(2) ROA	(3) ROA
Dgt	0.0033***		0.0038***
	(0.0008)		(0.0012)
lev	-0.0538***	-0.3104***	-0.0561***
	(0.0038)	(0.0360)	(0.0063)
ppe	-0.0717***	-0.0586***	-0.0632***

	(0.0083)	(0.0089)	(0.0129)
cash	0.0695***	-0.0011*	0.1075***
	(0.0053)	(0.0006)	(0.0134)
board	-0.0005*	-0.0005	-0.0001
	(0.0003)	(0.0004)	(0.0004)
dual	0.0005	-0.0015	-0.0035
	(0.0017)	(0.0029)	(0.0030)
age	0.0055*	0.0020**	0.0095*
	(0.0028)	(0.0008)	(0.0049)
lndgt		0.0077***	
		(0.0022)	
Constant	0.0359***	0.1357***	-0.0573
	(0.0114)	(0.0185)	(0.0543)
N	35,566	32,898	10,435
R-squared	0.1024	0.2047	0.0968

4.2 The mediating effect analysis

From the standpoint of enterprise innovation, the influence mechanism of digital transformation on enterprise performance is examined. The estimation results of mediating effects are presented in Table 4. In model (2) the Dgt's coefficient is significantly positive, suggesting that corporate innovation is greatly enhanced by digital transformation. In model (3), the coefficients of Dgt and innovare both significantly positive at a 1% level, indicating that enterprise innovation promotes enterprise performance. The intermediate effect part is 0.00055062 [0.00055062=0.1449*0.0038]. The regression analysis reveals that digital innovation indirectly improves firm performance through firm innovation. Hypothesis H2 is verified.

Model (4) and model (5) in Table 4 examined the impact of digital transformation on enterprise performance from the perspective of operational cost mechanism. Table 4's model (4) findings demonstrate that, at a 1% level, the Dgt's coefficient is notably negative, suggesting that digital transformation lowers operational costs for businesses. Model (5) cost's coefficient is significantly negative at a 10% level, indicating that reducing operating costs is conducive to improving enterprise performance. Intermediary effect 0.00057876 [0.00057876= (-0.0078) * (-0.0742)]. The regression results show that digital innovation indirectly improves firm performance by reducing operating costs. Hypothesis H3 is verified.

Table 4. Mediating effects of innovation and operating costs

	(1)	(2)	(3)	(4)	(5)
Variables	ROA	innov	ROA	cost	ROA
Dgt	0.0031***	0.1449***	0.0025***	-0.0078***	0.0025***
	(0.0008)	(0.0133)	(0.0008)	(0.0021)	(0.0008)
innov			0.0038***		
			(0.0006)		
cost					-0.0742*
					(0.0428)
lev	-0.0498***	0.5563***	-0.0519***	0.0399***	-0.0468***
	(0.0037)	(0.0461)	(0.0037)	(0.0115)	(0.0038)
ppe	-0.0722***	-0.0377	-0.0720***	0.0810***	-0.0662***
	(0.0085)	(0.1204)	(0.0084)	(0.0216)	(0.0090)
cash	0.0724***	-0.1093	0.0728***	-0.0819***	0.0663***
	(0.0058)	(0.0836)	(0.0057)	(0.0139)	(0.0069)

board	-0.0006**	0.0060	-0.0006**	0.0004	-0.0006**
	(0.0003)	(0.0038)	(0.0003)	(0.0006)	(0.0003)
dual	0.0002	0.0363	0.0001	0.0002	0.0002
	(0.0018)	(0.0255)	(0.0017)	(0.0063)	(0.0017)
age	0.0048*	0.0347	0.0047*	0.0092	0.0055**
	(0.0027)	(0.0461)	(0.0026)	(0.0071)	(0.0028)
Constant	0.0407***	0.5920***	0.0385***	0.6781***	0.0910***
	(0.0109)	(0.1797)	(0.0107)	(0.0285)	(0.0315)
N	35,647	35,647	35,647	35,647	35,647
R-squared	0.1009	0.2919	0.1037	0.0119	0.1389

5 Conclusions

Using the data of China's A-share listed companies from 2008 to 2020, this paper explores the effect of digital transformation on enterprise performance. By incorporating enterprise innovation and operating costs into the analysis framework, the influence of digital transformation on corporate performance is examined in this article. The findings of the regression demonstrate that, via raising corporate innovation levels and cutting operational expenses, enterprise digital transformation may, directly and indirectly, boost enterprise performance.

6 Suggestions

Digital transformation requires large capital, and high investment risk, and enterprises lack transformation resources and internal incentives. Therefore, to promote the digital transformation of enterprises, and improve enterprise performance, it is recommended to adopt the following policies: First, at the government level, timely promulgation of relevant support policies, such as tax incentives, government subsidies, etc., to help enterprises solve the difficulties they may encounter in the transition period. The government must improve the financing environment for digital transformation and build a diversified financing pattern, and actively encourage and guide financial market institutions and platforms to innovate financing methods and broaden financing channels. Second, at the enterprise level, they need to improve the top-level transformation system design and management and governance mechanism to help digital release its potential. Enterprises must clarify the specific responsibilities of various departments in the transformation, and effectively coordinate, at the same time, strengthen the training of digital talents, absorb innovative talents, not only pay attention to overseas talent acquisition channels, but also adopt more flexible employment methods to meet the gap of digital talents in enterprises.

This paper draws on previous studies when summarizing keyword frequency for digital transformation index measurement, it is difficult to avoid the subjectivity of word frequency selection. In the follow-up research, it can continue to enrich the keyword thesaurus. Secondly, ROA is only used to measure enterprise performance, and there are limitations in the selection of indicators. Subsequently, multiple performance indicators can be used for analysis to make the results more accurate.

References

[1] Bai, F.P., Liu, D.H., Dong, K.Y.: The impact of digital transformation on the financial performance of corporations: An examination of intermediary impacts using the structural equation. East China Economic Management. (9): 75-87 (2022)

[2] Briel, F. V., Recker, J., Davidsson, P.: Not all digital venture ideas are created equal: Implications for venture creation processes. The Journal of Strategic Information Systems. 27(4): 278-295 (2018)

[3] Ekata, E. G.: The IT Productivity Paradox: Evidence from the Nigerian Banking Industry. The Electronic Journal on Information Systems in Developing Countries. 51 (01): 1-25 (2012)

[4] Galindo-Martín, M., Castaño-Martínez, M., Méndez-Picazo, M.: Digital transformation, digital dividends, and entrepreneurship: A quantitative analysis. Journal of Business Research. 101 (2019)

[5] Hall, B. H., Griliches, Z., Hausman, J. A.: Patents and R&D: Is there a lag? International Economic Review. 27(2): 265-283 (1984)

[6] Liu, F., Tian, G.L.: Whether information technology replaces employment: Evidence based on Chinese Listed Companies. Science of Financial Economics. (7):95-107 (2019)

[7] Llopis-Albert, C., Rubio, F., Valero, F.: Impact of digital transformation on the automotive industry. Technological Forecasting and Social Change. (162):1-9 (2022)

[8] Liu, Z., Yao, Y.X., Zhang, G.S., et al.: Enterprise digitization, specialized knowledge, and organization authorization. China Industrial Economy. (09):156-174 (2020)

[9] Li, M., Jia, S.: Resource orchestration for innovation: The dual role of information technology. Technology Analysis & Strategic Management. (10): 1136-1147 (2018)

[10] Martínez-Caro, E., Cegarra-Navarro, J. G., Alfonso-Ruiz, F.J.: Digital technologies and firm performance: The role of digital organizational culture. Technological Forecasting and Social Change. 154: 119962- (2020)

[11] Masoud， R., Basahel, S.: The Effects of Digital Transformation on Firm Performance: The Role of Customer Experience and IT Innovation. Digital. 3:109-126 (2023)

[12] Nwankpa, J. K., Datta, P.: Balancing exploration and exploitation of IT resources: the influence of digital business intensity on perceived organizational performance. European Journal of Information Systems. 26(5): 469-488 (2017)

[13] Qi, H.J., Cao, X.Q., Liu, Y.X.: The impact of the digital economy on corporate governance: from the perspective of information asymmetry and irrational behavior of managers. Reform. (04):50-64 (2020)

[14] Wu, F., Hu, H.Z., Lin, H.Y., REN, X.Y.: Capital market performance and corporate digital transformation: Empirical evidence from stock liquidity. Management World. 37(07):130-144+10 (2021)

[15] Zhang, Z.G., Zhang, J.Q., Ye, B.S., Chen, Y.H.: The impact of enterprise digital transformation on business model innovation. Science and Technology Progress and Countermeasures, 39(11):114-123 (2022)