

Digital Transformation, Business Risk and Firm Value

-- An Empirical Test based on a Mediated Effects Model

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Abstract

With the continuous development of social economy and the emergence of new digital technologies, the community is increasingly concerned about the digital economy. Companies have been undergoing digital transformation, which is bound to have an impact on business operations due to the uncertainty of data flow and external conditions. This paper explores the impact path of digital transformation on enterprise value with the help of Bootstrap analysis, taking A-share listed companies from 2009-2019 as a sample, and the results show that digital transformation enhances enterprise value, in which enterprise business risk plays a fully mediated effect. A theoretical basis is provided for enterprises to promote digital economy and value enhancement.

Keywords

Digital Transformation; Business Risk; Enterprise Value; Mediation Effect; Bootstrap.

1. Introduction

With the emergence of artificial intelligence, big data, cloud computing and other new digital technologies, human society is accelerating into the era of digital economy, and various countries have attached importance to the development of the digital economy. 2021 Government Work Report pointed out that "accelerate digital development and build a new advantage in the digital economy", and the "14th Five-Year Plan" and 2035 Vision outline both proposed to "promote the deep integration of digital technology with the real economy". "The 14th Five-Year Plan and the 2035 Vision outline both propose to "promote the deep integration of digital technology and the real economy". Digitization has become the development trend of economy and society, and digital transformation has become the necessary road for future enterprise development [1]. Especially now that the epidemic has resumed and many companies are at risk of closing down, they need to find new ways to grow. The essence is to reduce the external risks and improve the internal resource allocation of the enterprise with the high-speed flow of data. And in this process, it will inevitably have some impact on the daily operation of enterprises. Therefore, the study of the role and path of the impact of digital transformation on enterprise business risks is conducive to promoting high-quality development of enterprises under the epidemic and promoting the smooth and healthy operation of the enterprise economy.

2. Literature Review and Research Hypothesis

2.1. Digital Transformation has an Impact on Enterprise Value

Gilch and Sieweke (2021) consider digital transformation as the use of digital technologies by companies to identify market opportunities and environmental changes through the integrated

use of specific technologies such as information, computing, communication, and connectivity [2]. Wu F et al. (2021) argue that digital transformation can bring a new momentum to the development of a company, promoting a deep integration of digital technologies with the existing production system of the company. And this data flow behavior and external uncertainty will inevitably have an impact on the business performance of enterprises [3]. Li Q (2021) and Huang D Y (2021) found that digital transformation is beneficial to the improvement of business performance and enterprise value [4-5]. Chen Y Z et al. (2021) concluded that digital transformation has a positive correlation effect on productivity [6].

2.2. Operational Risk has an Impact on Enterprise Value

Among the risks faced by firms, operational risk is a key factor in determining the value of a firm's future development, and Hu K (2021) argues that operational risk is closely related to firm value [7]. Ari Data (2019) tests and explains that operational risk has a positive impact on financial performance and firm value [8]. Zheng S Q (2022) further confirmed that reducing business risk can effectively enhance corporate value and promote the development of the firm [9].

In summary, several scholars have found that digital transformation can enhance enterprise value, and reducing business risks can also enhance enterprise value. Then it can be presumed that digital transformation and enterprise business risk have some connection, and the enhancement of digital transformation on enterprise value may be carried out through enterprise business risk. That is, there is a mediating effect of business risk in the impact of digital transformation on enterprise value. And there is less research on its mediating effect in academia. Based on this, this paper proposes research hypotheses 1 and 2.

H1: Other things being equal, digital transformation directly impacts enterprise value.

H2: Other things being equal, digital transformation indirectly affects enterprise value by acting on operational risk.

3. Study Design

3.1. Sample Selection and Data Sources

This paper selects the relevant financial data of A-share listed enterprises from 2009-2019 as the research sample, following the established empirical research practice, and treats the sample as follows: (1) Excluding the data of financial listed enterprises such as banks, insurance and securities. (2) Excluding ST and *ST enterprises. (3) Excluding listed companies that conducted IPOs in the years under analysis. (4) Excluding enterprises with uncompensable data deficiencies in the years examined. After the above screening, we finally obtained 18,588 annual observations of enterprises. At the same time, in order to mitigate the effects generated by the extreme values of the data, all continuous variables were tail-shrunk at the 1% and 99% levels. The data on digital transformation of enterprises are obtained from the annual reports of listed companies, and the rest of the financial data are obtained from the Guotaian database (CSMAR) and relevant financial data platforms such as Juchao Information Network.

3.2. Variable Settings

(1) Explained variables

Enterprise value (Tobin Q), Tobin Q value is currently recognized as a more accurate indicator of the market value of a company and is equal to the book value of (market value of equity + market value of debt)/total assets. Where the market value of equity is substituted by the outstanding share price and the market value of debt is measured by the book value of debt.

(2) Explanatory variables

Digital Transformation (DT), a text analysis method was used to construct the enterprise digital transformation index, and the specific steps were: first, the annual reports of listed enterprises from 2007-2019 were collected, and the text of MD&A section was extracted through Python. Second, based on the relevant word roots of data-based transformation provided by Fei Wu, Chen-Yu Zhao et al., we build a keyword mapping (as shown in Figure 1). Thirdly, we use Python to identify the roots of words, and exclude the roots with negative prefixes such as "no", "none" and "no". Fourth, the number of occurrences of the keywords for digital transformation of each enterprise was calculated and logarithmically processed to obtain the variable indicators for measuring digital transformation of enterprises.

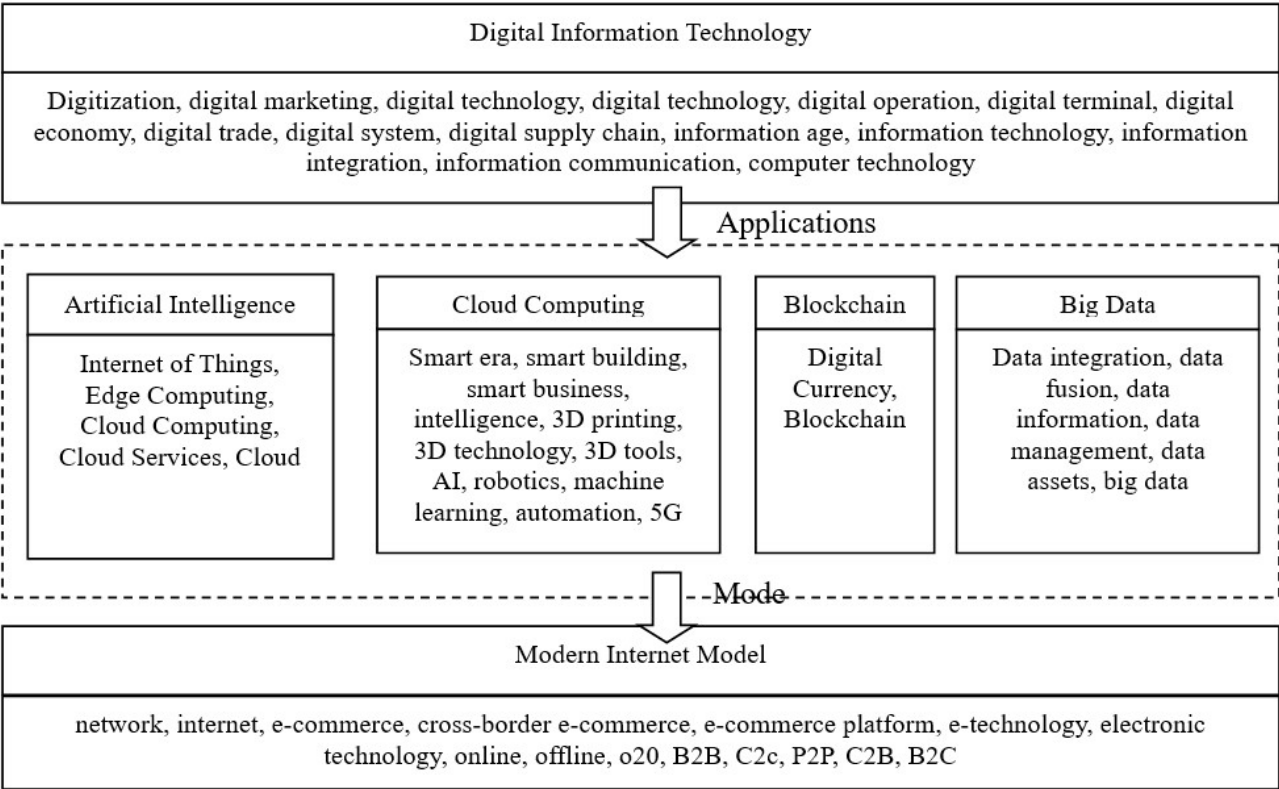


Figure 1. Digital transformation keyword mapping

(3) Intermediate variables

Business operating risk (DOL), operating risk is the change in losses and earnings due to the daily operations of the company. Based on the findings of Wang C Q (2017) on operational risk and working capital financing decisions [10], operational risk is calculated using the standard deviation of rolling values of EBITDA from year t-4 to year t-1 (four years).

(4) Control variables

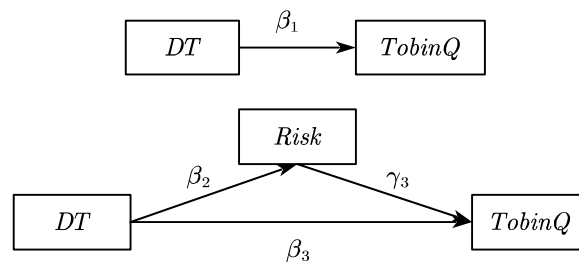
In addition to the three core variables mentioned above, to ensure the accuracy of the measurement test and to avoid the influence of other important factors, control variables on the firm level (as shown in Table 1) are selected to further control for potential factors affecting business risk and firm value.

Table 1. Variable definition table

Variable Type	Variable Name	Variable Symbols	Variable Explanation
Explained variables	Enterprise Value	Tobin Q	(Market value of stocks + book value of liabilities)/Total assets
Explanatory variables	Digital Transformation	DT	Ln (keyword word frequency + 1)
Intermediate variables	Business risk	Risk	Standard deviation of the return on total assets for three years t-1, t, t+1
Control variables	Gearing ratio	Lev	Total liabilities / total assets
	Asset turnover ratio	TAT	Operating income/total assets
	Enterprise size	Size	Ln (total assets)
	Return on Total Assets	ROA	Net profit/total assets
	Shareholding Concentration	Cent	Percentage of shareholding of the largest shareholder

3.3. Model Construction

This study examines the way digital transformation affects firm value with business risk as a mediating variable by constructing a mediating effects model (Figure 2).

**Figure 2.** Schematic diagram of the intermediary effect model

Drawing on the mediating effect test equation proposed by Wen Z L et al. (2004), a mediating effect test model is constructed for empirical testing [11].

$$TobinQ_{i,t} = \alpha_1 + \beta_1 DT_{i,t} + \delta_1 controls_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$Risk_{i,t} = \alpha_2 + \beta_2 DT_{i,t} + \delta_2 controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$TobinQ_{i,t} = \alpha_3 + \beta_3 DT_{i,t} + \gamma_3 Risk_{i,t} + \delta_3 controls_{i,t} + \varepsilon_{i,t} \quad (3)$$

In these three equations, $controls_{i,t}$ is a control variable and $\varepsilon_{i,t}$ is a random disturbance term that varies over time and across individuals. The first equation tests whether the effect of digital transformation on firm value is significant, where $TobinQ_{i,t}$ is the dependent variable, α_1 is a random variable that varies with individuals, and $DT_{i,t}$ denotes the digital transformation of the i th listed company at time t .

The second equation tests whether the effect of digital transformation on business risk (mediating variable) is significant, where $Risk_{i,t}$ is the dependent variable, α_2 is a random

variable that varies with individuals, and $DT_{i,t}$ denotes the digital transformation of the i th listed company at time t . The second equation tests whether the effect of digital transformation on business risk (mediating variable) is significant.

The third equation tests whether the effect of operational risk on firm value is significant after constraining the effect of digital transformation. Where $TobinQ_{i,t}$ is the dependent variable, α_3 is a random variable that varies with individuals, $DT_{i,t}$ denotes the digital transformation of the i th listed company at time t , and $Risk_{i,t}$ is the business risk of the i th listed company at time t .

4. Empirical Analysis

4.1. Descriptive Statistics

Table 2. Variable descriptive statistics

Variables	Sample size	Mean	Std	Min	Max
Tobin Q	18588	3.214	109.729	0.683	14810.310
DT	18588	0.059	0.111	0.002	1.248
Risk	18588	0.069	0.176	0.002	2.485
Lev	18588	0.408	1.150	0.007	138.377
TAT	18588	8.119	109.874	-0.425	8529.344
Size	18588	21.950	1.370	11.348	29.634
ROA	18588	0.033	0.601	-51.946	22.005
Cent	18588	33.983	14.699	2.626	89.985

The descriptive statistics of the main variables in this paper are shown in the table above. The maximum value of enterprise value (Tobin Q) is 14810.310, the minimum value is 0.683, the mean value is 3.214, and the standard deviation is 109.729, which indicates that the market value varies widely among enterprises. The maximum value of Digital Transformation (DT) is 1.248 and the minimum value is 0.002, with a difference of 1.246 in the middle, and the mean and standard deviation are 0.059 and 0.111, respectively, indicating that the degree of digital transformation of listed companies is generally low. The maximum value of operating risk (Risk) is 2.485, the minimum value is 0.002, the mean value is 0.069, and the standard deviation is 0.176, indicating that the operating risk of enterprises in different industries and industries varies greatly. The mean value of asset-liability ratio (Lev) is 0.408, which indicates that the financial risk of the sample enterprises is high. The average value of asset turnover ratio (TAT) is 8.119, and the minimum value reaches -0.425, indicating that the return on asset investment varies greatly among enterprises, and some enterprises have investment profit and loss. The mean value of enterprise size (Size) is 21.950, which indicates that the size of the sample enterprises is at a high level. The maximum value of return on total assets (ROA) is 22.005, the minimum value is -51.964, and the mean value is 0.033, which indicates that the sample enterprises have poor returns. Concentration of equity (Cent) has a maximum value of 89.985, a minimum value of 2.626, a mean value of 33.983, and a standard deviation of 14.699, indicating a large difference in the percentage of shares held by the largest shareholder among the listed companies.

4.2. Correlation Analysis

Table 3. Correlation Analysis

	Tobin Q	DT	Risk	Lev	TAT	Size	ROA	Cent
Tobin Q	1.000							
DT	0.009	1.000						
Risk	-0.321**	-0.980**	1.000					
Lev	0.032*	0.009	0.009	1.000				
TAT	0.033*	-0.003	-0.003	0.005	1.000			
Size	0.004	.015*	.015*	-0.054**	0.043**	1.000		
ROA	0.003	-0.006	-0.005	-0.602**	-0.003	0.040**	1.000	
Cent	0.024*	0.011	0.011	0.003	0.005	0.020**	-0.003	1.000

In order to verify the validity of the variables selected in this paper, the pearson correlation test was performed on the variables and the results are shown in Table 3. The explanatory variable Tobin Q does not show a positive correlation with the core explanatory variable DT, while it shows a significant positive correlation with the mediating variable Risk at 99% confidence interval, which initially rejects hypothesis 1 of this paper. The correlation coefficient is close to -1. This indicates that the main variables selected in this paper are valid.

4.3. Bootstrap Results Analysis

In this paper, the least squares method is used to estimate the regression of the model, and the estimation results are shown in Table 4:

Table 4. Results of the regression

	Tobin Q	Risk	Tobin Q
α	-3.724 (-0.285)	0.026** (-6.114)	-4.472 (-0.342)
Cent	0.024 (0.431)	-0.000 (-0.287)	0.023 (0.429)
TAT	-0.001 (-0.070)	0.000 (0.263)	-0.000 (-0.067)
Lev	0.535 (0.610)	0.000 (0.230)	0.536 (0.612)
ROA	0.529 (0.316)	0.000 (0.718)	0.540 (0.322)
Size	0.256 (0.435)	0.000 (0.701)	0.260 (0.441)
DT	4.854 (0.669)	-1.557** (669.264)	50.329 (1.385)
Risk			-29.206 **(-1.277)
Sample size	18588	18588	18588
R ²	0	0.96	0
Adjustment R ²	0	0.96	0
F	F (6,18581)=0.202 p=0.976	F(6,18581)=74686.546 p=0.000	F (7,18580)=0.406 p=0.899

Note: * indicates $p < 0.1$; ** indicates, $p < 0.05$; *** indicates, $p < 0.01$. The t-values are in parentheses.

Among them, the first column regression results are the results of the direct effect of the explanatory variable DT on the explanatory variable Tobin Q, and it is found that the effect of DT on Tobin Q is not significant. The second column indicates the regression results of the explanatory variable DT on the mediating variable Risk, and it can be found that digital transformation is significantly and negatively related to enterprise value at 99% confidence level, indicating that the greater the degree of digital transformation, the lower the business

risk of enterprises. The third column indicates the effect of the explanatory variable DT together with the mediating variable Risk on the explanatory variable Tobin Q. The results show that business risk is significantly negatively correlated with enterprise value at 99% confidence level, while the effect of digital transformation on enterprise value is not significant, which is consistent with the results obtained from the regression analysis in the first column and initially verifies hypothesis 2 of this paper.

The test results were based on the inclusion of "0" at 95% confidence interval, and the test results were considered significant if they did not include "0", and insignificant if they did not.

Table 5. Results of the intermediary effect test

Parameters	Total effect	Intermediary Effect	Direct effect	Boot SE	z	p	95% Boot CI
Value	4.854	-45.475	50.329	0.048	-952.786	0	-0.200 --- -0.029
Test conclusion	Full mediation effect						

According to the test results in Table 5, the interval of 95% Boot CI is -0.200 - -0.029 does not contain 0, which indicates that the mediating effect is significant, that is, business risk plays the role of mediating effect between digital transformation and firm value. Next, we determine whether the mediating effect is a partial or full mediating effect. According to the results in the table, it can be seen that the direct effect of digital transformation on firm value is insignificant, and the sign of the mediating effect value and the direct effect value are different signs, which means it is a complete mediating effect. That is, the effect of digital transformation on firm value is fully mediated by acting on the mediating variable Risk, which in turn affects the explanatory variable Tobin Q. Finally, the hypothesis 2 of this paper can be verified.

5. Conclusion and Suggestions

This paper constructs a mediating effect model with a sample of A-share listed companies from 2009-2019 and empirically analyzes the impact of digital transformation on enterprise value, and the research results show that digital transformation is through reducing enterprise business risk and thus increasing enterprise value, i.e., digital transformation can enhance enterprise value, and business risk plays a full mediating effect in the relationship between the two. Based on the theoretical analysis and empirical results, this paper puts forward the following policy recommendations.

- (1) The government and relevant departments should guide enterprises in digital transformation, build a policy system for digital development, and promote the development of digital economy. Give strong policy and economic support to those who are undergoing digital transformation, such as tax exemptions and government subsidies, etc.
- (2) Enterprises should follow the development trend of digital economy, focus on the integration of digital technology with their traditional advantageous business, set long-term development goals, ensure the premise of business development, and commit to digital transformation to improve the future enterprise value.

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