The Impact of Digital Transformation on the Debt Financing Costs of Firms

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Abstract: The digital economy, with digital technology as its core driving force, is subverting the traditional economic and social operating model. In the context of the deep integration of the digital economy and the real economy, digital transformation is the consensus of almost all firms. As the first driving force of the firm's operations, financing activities will inevitably be affected by the digital transformation of firms. Based on the perspective of financing, this study empirically tests the impact of digital transformation of firms on the cost of debt financing. When measuring variables, this study uses the technology of data mining and text analysis to measure the extent of digital transformation of firms. The research results show that the digital transformation of firms is significantly negatively related to the cost of debt financing. In addition, for firms with different equity nature, there are significant differences in the impact of digital transformation on the cost of debt financing.

1. Introduction

At present, the global digital transformation is accelerating, and changes and innovations follow. Digital technology is being fully integrated into all fields and the whole process of human economy, politics, culture, society, and ecological civilization construction with new concepts, new business forms, and new models. It has become a key force to reorganize global factor resources, reshape the global economic structure, and change the global competition pattern. With digital technology as the core driving force, the digital economy is subverting the traditional economic and social business model and creating new development opportunities. As a new economy based on the networking of human intelligence, the digital economy promotes the transformation of human economy from industrial economy to information economy and knowledge economy, with the continuous upgrade of network infrastructure, information tools, and information technologies such as the Internet, Cloud Computing, Blockchain, and the Internet of Things.

The digital transformation of firms is an important part of the digital economy. Firm digital transformation refers to the digital transformation of the entire value chain of the enterprise, involving various aspects such as operation management, production and sales, financial activities, etc., using digital technology to continuously promote the continuous dynamic upgrade of value creation activities. At present, digital transformation has become a vital choice for firms to achieve overtaking on curves and obtain sustainable development momentum. It brings new opportunities for innovation and reform, helps firms adapt to the changing environment, and continuously creates new value growth points. In the era of the digital economy, digitization has gradually played an increasingly vital role in the development of firms, and has become the "firm brain" that empowers firm value creation. In the future, digital transformation will be a major challenge and an important opportunity for firms.

What specific impacts will digital transformation bring to firms? Most existing researches focus on the impact of digital transformation on firm performance, internal control mechanism and operation management. However, the relationship between digital transformation and financing has rarely attracted the attention of researchers. The development of a firm is a process of financing, development, re-financing and re-development. As the starting point of operation and production, financing activities play a pivotal role in the development of firms. Whether a firm can obtain the stable source of funds determines whether it can continue to develop steadily in the future. In addition, firm financing should generally follow the principle of low financing cost. Because financing costs are the decisive factor of the financing efficiency. Excessive debt cost may lead to operational risk. Digital transformation is the transformation of the whole value chain of firms, which will inevitably have a significant impact on the financing activities. In theory, digital transformation will enhance the adaptability and anti-risk ability of firms, and improve firm performance, thus effectively improve the

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credit rating of firms and reducing debt financing costs. This study will empirically test the impact of digital transformation on the debt financing costs of firms, in order to complement the blank space of the correlative research.

2. Literature review and research hypotheses

2.1 Digital transformation

There is a fair amount of research already done on the connotation, motivating forces, and impact mechanisms of digital transformation. At the micro level, the research on the digital transformation of firms focused more on business strategy, organizational structure, and performance. Existing research has found that the digital transformation of firms is mainly reflected in technology application (Vial, 2019) [1], innovation integration (Hanelt et al., 2021) [2], business reorganization (Westerman et al., 2014) [3], organizational change and cross-system change (Xiao et al., 2020) [4]. Digital transformation can boost corporate performance (Bekkhus, 2016) [5], enhance corporate resilience (Jiang et al., 2022) [6], improve organizational efficiency (Goldfarb and Tucker, 2019) [7], promote corporate innovation (Loebbecke and Picot, 2015) [8], and gain competitive advantage (Hanelt et al., 2021) [2]. In addition, some research focused on the effects of digital transformation on total factor productivity (Zhao et al., 2021) [9], capital market performance (Wu et al., 2021) [10], division of labor (Yuan et al., 2021) [11], and input-output efficiency (Liu et al., 2021) [12]. Most research on digital transformation takes a qualitative approach. There are also some empirical studies using text analysis methods. However, up to now, relevant research using data mining to measure digital indices still lacks attention to firm debt financing.

2.2 Debt financing costs

Debt financing is a significant source of funding for firms. The sustainable operation of firms depends greatly on finding ways to lower borrowing costs. There is abundant research on the influencing factors of debt financing cost. Some academics have noted that sound internal control mechanisms (Ashbaugh et al., 2004) [13], high-quality information disclosure (Partha, 1998) [14], independent boards of directors and independent audit committees can all lower firm debt costs (Ronald et al., 2004) [15]. In addition, Karjalainen (2001) [16] came to the conclusion that firms can finance with lower costs of debt if their audit reports are unqualified opinions. Su et al. (2011) [17] discovered that if the firm's director has a banking background, it can acquire finance at a reasonable cost.

2.3 Digital transformation and debt financing costs

Few articles demonstrate the quantitative relationship between digital transformation of firms and the cost of debt financing. We speculate that the digital transformation of firms may improve the borrowing capacity and reduce financing costs from the following two aspects. First, digital transformation has a significant positive impact on corporate resilience (Jiang et al., 2022) [6]. Sanchis and Poler (2019) [18] believe that the three main characteristics of corporate resilience are antifragility, adaptability, and resilience. Resilient companies have strong resilience to risks and will apply strategies appropriately to survive in the face of various shocks (Mohamed and Edeen, 2018) [19]. Firms facing financing constraints may offset the adverse effects of financing constraints through self-accumulation due to firm resilience (Moll, 2014) [20]. The enhanced anti-risk capability of the firm will correspondingly reduce the default risk, thereby reducing the debt financing cost. Second, the digital transformation of firms can improve firm performance (Bekkhus, 2016) [5], and help firms create new value growth points. Good profitability and stable development prospects ensure the repayment ability of the firm, improve the credit rating, and thus enhance the financing ability and efficiency. Based on the above analyses, the following assumptions are made:

H1: The cost of debt financing will be reduced as a result of firms' digital transformation.

3. Research design

3.1 Data source and sample selection

In this study, Chinese A-share listed companies on Shenzhen Stock Exchange main board from 2011 to 2020 were selected as the research sample. In order to ensure the representativeness of the sample, the initial samples were processed as follows: (1) excluding listed companies in ST, * ST, and financial industries, (2) excluding samples with missing or abnormal data. The annual reports of listed companies used in this study were obtained from the Juchao information network (http://www.cninfo.com.cn). Financial and governance data for sample companies were captured in the CSMAR database and the WIND database. And the macro data were from the National Bureau of Statistics of China.

3.2 Model design and variable definition

In order to explore the relationship between digital transformation and debt financing costs, especially to understand how digital transformation affects corporate debt financing costs, we construct the model (1) for research:

$$\mathrm{DebtCost}_{i,t} = \alpha_0 + \alpha_1 \mathrm{DGT}_{i,t} + \sum \mathrm{Controls} + \varepsilon \quad (1)$$

$\mathrm{DebtCost}_{i,t}$ represents the explained variable, $\mathrm{DGT}_{i,t}$ represents the explanatory variable, ε represents the

random disturbance term, and α_1 represents the impact of digital transformation on debt financing costs.

3.2.1 Explained variable: debt financing costs

Refer to existing research, two methods are used to measure debt financing costs in this study. The first method is to measure the cost of debt financing (DebtCost1) by dividing the firm's interest expense by its total liabilities. The second method measures the cost of debt financing (DebtCost2) by dividing the sum of the firm's interest expenses plus expenses and other financial expenses by the firm's total liabilities. For convenience purpose, we multiply the value of the proxy variable for debt financing costs by 10,000.

3.2.2 Explanatory variable: digital transformation

Managements' increased focus on digitalization is conducive to enhancing the degree of digitalization of firms, which can be reflected in temporary and regular announcements. Based on the annual reports of A-share listed companies on Shenzhen Stock Exchange main board, we use web crawler technology to extract the keywords represented by "big data", "artificial intelligence", "digital finance", "digital economy", "mobile Internet", "Internet of Things", "O2O", "cloud computing", "multi-party security computing", "business intelligence" and "virtual reality", and conduct word frequency statistics for this type of keywords. The number of word frequencies (DGT) is used as a proxy variable to measure the extent of firm digital transformation.

3.2.3 Control variables

Drawing on the existing literature, we select a series of control variables which may affect the debt financing costs, including company size (Size), financial leverage (Lev), operating cash flow ratio (OCF), average accounts receivable turnover ratio (RTR), profitability (ROE), operating income growth rate (Growth), equity concentration (HH5), concurrent position of chairman and general manager (Con), year (Year) and industry (Ind) dummy variables.

4. Empirical results and analysis

4.1 Descriptive statistics

Table 1 presents the descriptive statistical results for all the variables. As shown in Table 1, the average proportion of financial expenses to total liabilities of listed companies was 1.65% between 2011 and 2020, with a maximum of 5.91%. In addition, some listed companies stated multiple terms about digital transformation in their annual reports, with a maximum of 33 times, showing that the digital transformation of Chinese listed companies was widely implemented. Moreover, the mean and standard deviation of DGT respectively were 0.940 and 2.703, indicating that the extent of digital transformation varied greatly among different firms.

Table 1. Descriptive statistical results for the main variables

variable	N	mean	sd	min	p50	max
DebtCost1	1778	0.007	0.101	0	0	2.057
DebtCost2	1744	165.3	205.5	-506.1	172.6	590.8
DGT	1779	0.940	2.703	0	0	33
Lev	1744	0.493	0.186	0.094	0.502	0.844
OCF	1744	0.172	0.254	-0.416	0.120	1.174
RTR	1744	46.99	116.0	1.650	10.12	1131
ROE	1744	0.077	0.073	-0.173	0.069	0.290
Growth	1744	0.439	1.217	-0.556	0.113	12.20
HH5	1744	0.154	0.112	0.020	0.124	0.545
Con	1814	0.181	0.385	0	0	1
Size	1743	22.34	1.118	20.03	22.23	25.26

4.2 Multiple regression analysis

Digital transformation can improve firms' ability to resist risks, reduce their default risk, and thus reduce debt financing costs. In addition, digital transformation can help firms improve performance, create new value growth points, and enhance firm financing capabilities and efficiency. Model (1) was regressed to test hypothesis H1. And the estimated results are reported in Table 2.

Table 2. Digital transformation and debt financing costs of firms: Total sample regression results

	(1) DebtCost1	(2) DebtCost2	(3) DebtCost1	(4) DebtCost2
DGT	-0.001**	-3.473**	-0.001**	-2.949*
	(-2.13)	(-2.27)	(-2.06)	(-1.86)
Lev			-0.022	461.156***
			(-1.36)	(12.49)
OCF			0.002	119.861***
			(0.46)	(4.38)

RTR			-0.000	-0.142***
			(-0.14)	(-2.77)
ROE			0.029	-502.165***
			(0.74)	(-6.64)
Growth			0.000	-17.060***
			(0.00)	(-3.68)
HH5			-0.004	-127.289***
			(-0.21)	(-2.84)
Con			0.004	-9.057
			(0.55)	(-0.68)
Size			0.009*	-9.120*
			(1.77)	(-1.80)
Ind	yes	yes	yes	yes
Year	yes	yes	yes	yes
Constant	0.008***	168.770***	-0.186*	228.710**
	(2.98)	(31.63)	(-1.85)	(2.17)
Observa-tions	1,748	1,709	1,367	1,354
R-squared	0.000	0.002	0.009	0.167
adj_R2	0.160	0.160	0.160	0.160
F	28.34	28.34	28.34	28.34

Note: t-values are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Based on the regression results, the degree of digital transformation of firms is negatively correlated with the proxy variables of debt financing cost, DebtCost1 and DebtCost2, at the 5% significance levels, in the univariate regression. It shows that the digital transformation can reduce the debt financing cost of firms. After adding control variables, DGT is still negatively correlated with DebtCost1 and DebtCost2 at the 5% and 10% significance levels, respectively. The regression results are consistent with hypothesis H1.

4.3 Robustness test

In order to eliminate the endogeneity problem caused by reverse causality, we draw on the practice of Yuan et al. (2021) [11], and select the multiplication of the national netizen size and the post and telecommunication business volume of each province in 1998 as an instrumental variable (IV). The communication situation of various cities in the past development process reflects the regional technical level and social preference, which then affects the acceptance of digital transformation by firms during the sample period. Meanwhile, as a social infrastructure, post and telecommunications have no direct impact on firm financing costs and are exogenous. As shown in Table 3, the coefficients of the instrumental variable are significantly negative, which is consistent with our hypothesis.

Table 3. Robustness Test

	(1)	(2)
	DebtCost1	DebtCost2
IV	-0.000341**	-0.010*
	(-2.13)	(-1.81)
Lev	-0.033*	428.469***
	(-1.94)	(12.68)
OCF	0.006	121.825***
	(0.73)	(5.60)
RTR	0.000	-0.098***
	(1.04)	(-6.10)
ROE	0.042	-497.480***
	(0.96)	(-8.02)
Growth	-0.001**	-5.414**
	(-2.21)	(-2.08)
HH5	0.009	-153.143***
	(0.48)	(-3.98)
Con	0.016	-13.333
	(1.39)	(-1.07)
Size	0.010**	-7.516
	(2.24)	(-1.64)
Ind	yes	yes
Year	yes	yes
Constant	-0.202**	220.120**
	(-2.26)	(2.28)
Observations	1,500	1,484
R-squared	0.014	0.176
adj_R2	0.171	0.171
F	37.18	37.18

Note: t-values are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

5. Further research

In order to explore the heterogeneous influence of the equity nature, the sample was divided into state-owned firms and non-state-owned firms according to the equity nature, and grouped for regression statistics. As shown in Table 4, the estimated coefficients of DGT are only significantly negative in the state-owned firms' group, but not statistically significant in the non-state-owned firms' group. This indicates that the impact of digital transformation on debt financing costs varies among firms with different equity nature, and the impact is more significant in state-owned firms. Due to the different nature of equity, compared with non-state-owned firms, state-owned firms have more convenience in resource acquisition, government support, policy preferences, and so on. As a result, when state-owned firms face operating difficulties, the government will extend a "helping hand" to provide a greater degree of financial support, such as providing convenience in financial subsidies and capital market financing. The government implicitly guarantees the operation and development of state-owned firms to some extent. As a result, the "bold attempt" of the digital transformation of state-owned firms is more secure, and the benefits of digital transformation are more easily reaped by state-owned firms.

Table 4. Heterogeneity analysis of equity nature

	(1)state-owned firms	(2)non-state-owned firms	(3)state-owned firms	(4)non-state-owned firms
	DebtCost1	DebtCost1	DebtCost2	DebtCost2
DGT	-0.002*	-0.001	-5.503**	0.994
	(-1.83)	(-1.02)	(-2.10)	(0.34)
Lev	-0.042	-0.006	487.705***	344.845***
	(-1.49)	(-0.77)	(10.59)	(6.13)
OCF	-0.011	0.018	140.631***	78.300**
	(-1.31)	(1.08)	(4.96)	(2.18)
RTR	0.000	0.000	-0.105***	-0.083***
	(0.32)	(0.88)	(-4.86)	(-4.23)
ROE	0.071	0.055	-464.206***	-466.229***
	(1.55)	(0.94)	(-5.36)	(-4.37)
Growth	-0.001	-0.001	-0.770	-5.027
	(-0.75)	(-0.90)	(-0.25)	(-0.96)
HH5	0.002	0.022	-160.417***	-136.257**
	(0.07)	(0.72)	(-3.05)	(-2.39)
Con	0.040	0.001	-40.446**	-0.549
	(1.27)	(0.34)	(-2.15)	(-0.03)
Size	0.010	0.005	-2.487	-8.080
	(1.42)	(1.38)	(-0.36)	(-1.06)
Year	yes	yes	yes	yes
Ind	yes	yes	yes	yes
Constant	-0.234	-0.114	-7.360	299.065*
	(-1.49)	(-1.31)	(-0.05)	(1.89)
Observa-tions	847	647	842	636
R-squared	0.022	0.027	0.229	0.150
adj_R2	0.133	0.133	0.133	0.133
F	14.10	14.10	14.10	14.10

Note: t-values are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

6. Conclusion

This study employs a method that combines text analysis and empirical analysis to examine the influence of digital transformation on the cost of debt financing. The results show that digital transformation is significantly negatively correlated with debt financing costs, and the regression results are still reliable after the robustness test. This indicates that firms can actively carry out digital transformation to reduce the cost of debt financing. In addition, the impact of digital transformation on debt financing costs varies by equity nature and is more significant in state-owned firms. This is because it is easier for state-owned firms to obtain resources and government support to carry out digital transformation. So state-owned firms are easier to obtain the benefits of digital transformation.

This research enriches the research on the impact of digital transformation on firms at the micro-level, as well

as fills the research gap in the relationship between firm digital transformation and debt financing costs. This also provides empirical evidence and management enlightenment for firms to embrace digital transformation to reduce debt financing costs. First, firms should seize new opportunities in the development of the digital economy. Keep up with market trends and actively carry out product structure adjustment and business model innovation. Utilize the new generation of information technology to continuously improve industrial development capabilities, establish a dynamic and digital system to adapt to innovation-driven market demands, and meet customer demands for high-tech, customized and complex products and services. Second, firms should manage risks in the digital transformation process. In the process of firm digital transformation, due to changes in technological investment and organizational structure, a series of financial, operational and strategic risks will be brought. If the digital transformation strategy suitable for firm development is not adopted, these risks are likely to lead to the failure of firm operation. Therefore, the firm's management should take the initiative to think about digital strategy with a positive attitude, and choose a stable, active or conservative digital transformation strategy according to its own profitability, cash flow, financing ability and other factors.

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