Digital Transformation and Enterprise Financing Constraints

Xiaoxiao Shao, Liu Yang*
1316798768@qq.com, * Corresponding author: 10090092@henu.edu.cn

Business School of Henan University, Kaifeng, China

Abstract—This paper examines the impact of digital transformation of enterprises on their financing constraints, using data from A-share listed companies from 2009 to 2020 as a sample. The findings show that: (1) based on an investment-cash flow sensitivity model, digital transformation is found to significantly alleviate the financing constraints of enterprises. (2) In terms of heterogeneity, digital transformation of enterprises is more effective in alleviating their financing constraints in regions with a high degree of financial development and a good legal environment. (3) In terms of the path of action, digital transformation significantly increases new bank loans and new equity financing, but has no significant impact on new bond financing. This result remains robust after accounting for endogeneity.

Keywords- digital transformation; financing constraints; asymmetry of information; debt financing; equity financing

1. Introduction

In recent years, the widespread application of a new generation of information technology characterized by big data has made the digital transformation of enterprises a hotspot for economic and social development, and the impact of digital transformation on enterprises has received widespread attention. Scholars have already studied the economic consequences of corporate digital transformation in terms of stock liquidity [1], stock price synchronization [2], corporate factor productivity [3], corporate innovation performance [4]. In their theoretical analysis of the mechanism of action, most of these literatures have identified the alleviation of financing constraints as an important mechanism [5]. However, there is a lack of rigorous empirical testing and full exploration of whether digital transformation can significantly alleviate the financing constraints of firms, how heterogeneous its alleviation effect is, and through which path of exogenous financing.

This paper takes the data of A-share listed companies from 2009 to 2020 as a sample to study the impact of digital transformation of enterprises on their financing constraints and its path of action. The main research content and its findings: (1) Drawing on the research design of [6], an empirical investment-cash flow sensitivity model is constructed to study the impact of enterprises' digital transformation on their financing constraints, and the results show that enterprises' digital transformation can significantly alleviate their financing constraints. (2) On the basis of the above study, two macro-influencing factors, namely the degree of financial development and the legal environment, were introduced to study the influence of macro-environmental factors on the effect of digital transformation on alleviating enterprises' financing constraints, and

BDEIM 2022, December 02-03, Zhengzhou, People's Republic of China

DOI 10.4108/eai.2-12-2022.2328724

it was found that a high degree of financial development and a good legal environment were more conducive to digital transformation in alleviating enterprises' financing constraints. (3) In terms of the path of the effect of digital transformation on enterprises' financing constraints, this paper further examines the path of digital transformation in alleviating financing constraints from two major types of external financing, namely new debt financing and new equity financing, and finds that digital transformation can significantly increase the scale of new debt financing and new equity financing of enterprises, and when further dividing new debt financing into new bank loans and When further separating new debt financing into new bank loans and new bond financing, it is found that the effect of digital transformation in increasing new debt financing for firms is mainly in terms of bank loans, while there is no significant effect on new bond financing, and these results remain robust after accounting for endogeneity issues.

The contribution of this paper is that: (1) From a micro perspective, it empirically tests the effect of digital transformation on the alleviation of enterprises' financing constraints, providing theoretical and empirical support for the existing studies on the economic consequences of digital transformation based on the mediating effect of financing constraints; (2) This paper introduces external macro-environmental factors into the empirical evidence to study the heterogeneous impact of enterprises' digital transformation on their financing constraints, providing an important reference for the government to encourage; (3) The paths of digital transformation on enterprises' financing constraints are discussed, which helps to deeply understand the impact of digital transformation on the financing environment of enterprises in China and enriches the relevant studies on the economic consequences of digital transformation.

2. Literature Review and Research Hypotheses

2.1 Literature Review and Research Hypotheses

[7] developed the financing constraint hypothesis based on the theory of information asymmetry, which pioneered the study of the investment-cash flow sensitivity relationship of firms under financing constraints. In such a situation, a firm can only rely on internal cash flow in order to take advantage of investment opportunities, as its external financing behavior will be hindered by inadequate external financing channels. Moreover, the greater the difference in the cost of internal and external financing, the stronger the financing constraint effect. It is generally accepted that information asymmetry is one of the major causes of external financing constraints and that reducing information asymmetry can reduce financing constraints [7]. Digital transformation of enterprises can, to a certain extent, reduce the information asymmetry of the outside world to enterprises and strengthen positive market expectations [8][9], which provides new ideas to solve the problem of corporate financing constraints.

There are two possible reasons for the impact of digital transformation of companies on financing constraints. First, digital transformation helps to reduce the efficiency of information processing and transmission. After digital transformation, enterprises can accelerate the process of informatization with the help of their own digital technology and greatly enhance their information processing capabilities, making it more convenient, effective, and fast to analyze, process and disseminate various types of information and improve information utilization [1]. At the same time, digital transformation empowers enterprises to quickly connect internal and external information sources, breaking down the communication barriers between enterprises and

the outside world, strengthening information exchange and interoperability, and expanding the breadth and depth of information [4]. [9] also point out that after digital transformation, enterprises can communicate their information to the outside world at a lower cost and with higher efficiency, and their dissemination is also wider. As a result, digital technology not only reduces the cost of information disclosure, but also increases the ability and motivation of companies to disclose information, and when information needs to be disclosed to external information users, managers are fully equipped to make information uncertainty and asymmetry lower and information transparency higher [8].

Secondly, digital transformation can send positive signals to the outside world about the quality of the company and reduce the information asymmetry of the outside world about the company. The act of digital transformation has a positive "exposure effect" and can release positive signals to the outside world. Firstly, studies have shown that after digital transformation, enterprises have greatly improved their ability to process internal and external information and the efficiency of information transmission, making it easier for managers to access internal and external information, reducing the irrationality of managers' decision-making behavior and helping them to make decisions, thus improving corporate governance [8]. That is to say, the very act of a firm undergoing digital transformation is evidence of its high quality of development, which helps to reinforce positive market expectations. Secondly, digitally transformed companies can not only send positive signals about their development to the outside world through annual report disclosure and investment in actual production technology transformation, but also these signals will quickly react to the market with the accelerated flow of information. In addition, the digital transformation of enterprises is in line with the current trend of digital economy and national development strategy, which will be sought after in the capital market and the market valuation of enterprises will rise, thus attracting a lot of media and analysts' attention and investors' follow-up [1]. Information intermediaries such as analysts can in turn facilitate the flow of corporate information to many external investors who are at an information disadvantage. In short, digital transformation of enterprises can reduce information asymmetry from both internal and external sources, which will improve the availability of financing for enterprises and thus alleviate their financing constraints. Accordingly, this paper puts forward the hypothesis:

H1: Digital transformation of enterprises can significantly ease financing constraints.

2.2 Analysis of the Interaction Effects of the Macro Environment on the Impact of Financing Constraints on the Digital Transformation of Enterprises

Financial development helps firms overcome moral hazard and adverse selection caused by information asymmetry by optimizing the institutional environment, improving the legal system, and improving corporate governance mechanisms [10]. First, financial development promotes the maturity of the market, thus reducing the search cost of information. Financial development drives the development of financial intermediaries, and the deepening of financial development can provide powerful information identification for various elements of economic growth, including financial intermediaries, through which the ability of financial intermediaries to obtain and process enterprise information and the sensitivity of information can be improved[10], when the information that enterprises carry out digital transformation is also more likely to be noticed and valued The signal effect of digital transformation can be maximized with the help of financial intermediaries. Second, as the level of financial development increases, the market mechanism can function better. The higher the level of financial development and the higher the degree

of marketisation, the less government intervention in financial institutions and enterprises, and the greater the role of market mechanisms, the more efficient the allocation of credit resources in the market, and the greater the effectiveness of signals in the market [11]. In summary, the positive signaling role played by digital transformation is stronger at high levels of financial development, whereby this paper proposes a second hypothesis:

H2: Ceteris paribus, the higher the degree of financial development, the stronger the role of digital transformation of firms in influencing financing constraints.

The legal environment of the region in which a company is located not only has a significant impact on the effective protection of local investors and companies, but also on the level of information asymmetry. On the one hand, a good legal environment can significantly reduce the degree of information asymmetry in the market. When the regional legal environment is good, investors' rights are well protected and local information disclosure requirements for companies are higher. On the other hand, a sound legal environment can improve the efficiency of market operations. The improved level of rule of law strongly restrains local government intervention, ensures the operation of market mechanisms, and promotes financial development [11], thus ensuring that market signals function effectively. Therefore, when the legal environment is better, the digital transformation of enterprises also plays a stronger signaling role, and the digital transformation of enterprises and the legal environment can produce a better synergy effect. In summary, this paper proposes a third hypothesis.

H3: Ceteris paribus, the better the legal environment, the stronger the role of corporate digital transformation in influencing financing constraints.

3. Research Design

3.1 Sample Selection and Data Sources

This paper sets A-share listed companies from 2009 to 2020 as the initial sample. In addition, in order to ensure the feasibility of the data, the following screenings were made: (1) exclude ST companies and PT companies; (2) exclude the financial and insurance sectors and companies with incomplete data. All data in this paper are obtained from the CSMAR database. In order to avoid the influence of outliers, the continuous variables in this paper are subjected to an upper and lower 1% tail winsorized.

Table 1 Descriptive and definitions of main variables

Variable	**Symbols**	**Variable definitions**
Digital transformation	*Digital*	The frequency of the words "digital transformation of enterprises" in the annual reports of listed companies is added by 1 and logarithmically calculated, to portray the extent of their transformation.
Investment expenditure	*Inv*	Cash paid for the acquisition of fixed assets intangible assets and other long-term assets

Internal cash flow	*Cf*	Net cash flows from operating activities/total assets at beginning of period
Financial Development	*Fin*	Using the "Marketization of the Financial Sector" index measure in X. Wang and G. Fan's China Marketization Index Report by Province (2021) [12].
Legal environment	*Law*	Using the "Development of Market Intermediary Organizations and Legal Institutional Environment" index in X. Wang and G. Fan's China Marketization Index Report by Province (2021) [12].
Gearing ratio	*Lev*	Total liabilities/total assets
Growth	*Growth*	(Total assets at end of period - Total assets at beginning of period)/Total assets at beginning of period
Liquidity ratio	*Liquid*	Total current assets/total current liabilities
Firm's Age	*Age*	Difference between the year of observation and the year of establishment of the firm

3.2 Variable Design

- Explained variable: Financing constraints: It has been shown in previous theoretical analyses that a firm's financing constraint is related to internal cash flows, and previous research has shown that investment-cash flow sensitivity can measure a firm's financing constraint to some extent [7]. This paper therefore uses investment-cash flow sensitivity to measure the magnitude of the financing constraint. Of which, investment expenditure (Inv)：Cash paid for the acquisition of fixed assets intangible assets and other long-term assets. Internal cash flow (Cf)：Net cash flows from operating activities to total assets at the beginning of the period.

- Explanatory variable: Enterprise digital transformation (Digital): Referring to [1], the frequency of the words "digital transformation of enterprises" in the annual reports of listed companies is added by 1 and logarithmically calculated, to portray the extent of their transformation.

- Other variables: The definitions and symbols of the other variables are listed in Table 1.

3.3 Model Design

In order to test whether the digital transformation of firms can effectively alleviate the financing constraints of firms, this paper draws on the research design of [6] to construct an empirical model of investment-cash flow sensitivity as follows:

$$Inv_{i,t} = \beta_0 + \beta_1 Digital_{i,t} + \beta_2 Cf_{i,t-1} + \beta_3 Digital_{i,t} \times Cf_{i,t-1} + \alpha Controls_{i,t-1} + \gamma Controls_{i,t-1} \times Cf_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

Controls are control variables, including gearing (*Lev*), growth (*Growth*), firm age *(Age*) and current ratio (*Liquid*), in addition to controlling for industry fixed effects and year fixed effects. For model (1), β_2 is used to measure the magnitude of the financing constraint. If β_2 is positive,

then the firm's investment is dependent on internal cash flows, i.e., the firm is subject to external financing constraints. We use the coefficient β_3 of $Digital_{i,t}*Cf_{i,t-1}$ to measure the effect of digital transformation on the financing constraint of the firm, and if β_3 is negative, it indicates that digital transformation *Digital* alleviates the financing constraint.

In order to test how the degree of financial development and the legal environment affect the effect of digital transformation of enterprises on financing constraints, i.e., H2 and H3, this paper further adds the cross-sectional variables of the degree of financial development (*Fin*), legal environment (*Law*) and digital transformation (*Digital*) and cash flow (*Cf*) to model (1) to obtain model (2) and model (3).

$$Inv_{i,t} = \beta_0 + \beta_1 Digital_{i,t} + \beta_2 Cf_{i,t-1} + \beta_3 Digital_{i,t} \times Cf_{i,t-1} + \beta_4 Fin_{i,t} + \beta_5 Fin_{i,t} \times Digital_{i,t} \times Cf_{i,t-1} + \alpha Controls_{i,t-1} + \gamma Controls_{i,t-1} \times Cf_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

$$Inv_{i,t} = \beta_0 + \beta_1 Digital_{i,t} + \beta_2 Cf_{i,t-1} + \beta_3 Digital_{i,t} \times Cf_{i,t-1} + \beta_4 Law_{i,t} + \beta_5 Law_{i,t} \times Digital_{i,t} \times Cf_{i,t-1} + \alpha Controls_{i,t-1} + \gamma Controls_{i,t-1} \times Cf_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

In models (2) and (3), a positive coefficient β_5 indicates that the higher the financial development and the better the legal environment, the more effective the digital transformation of companies is in influencing financing constraints.

4. Empirical Results

4.1 Variable Descriptive Statistics

Table 2 shows the descriptive statistics of the main variables, from which it can be seen that: the mean value of digital transformation *Digital* is 1.0018, with a variance of 1.2549, which indicates that there is a large difference in the degree of digitalization among individual companies; the mean value of *Inv* for company investment expenditure is 0.0629, which is greater than the median value of 0.0429 , which indicates that most companies' investment is distributed above 0.0429; the mean value of net cash flow *Cf* is 0.0531, which is closer to the median value of 0.0509, but the amplitude between the maximum and minimum values is larger, indicating the diversity of companies' financial situation; the mean values of new debt financing and new equity financing to total assets are 3.34% and 4.13% respectively, of which new bank loans account for 2.84% of total assets and new bond financing.

Table 2 Descriptive statistics of main variables

Variable	N	mean	p50	sd	min	max
Digital	16192	1.0018	0.6931	1.2549	0	4.7622
Inv	16192	0.0629	0.0429	0.0643	0.0003	0.3483
Cf	16192	0.0531	0.0509	0.0908	-0.2416	0.3738
Debts	16192	0.0334	0.0094	0.1028	-0.1855	0.4896
Equity	16192	0.0413	0	0.128	-0.0517	0.8282
Bank	16192	0.0284	0.0068	0.096	-0.1842	0.4594

Bond	16192	0.0047	0	0.0326	-0.0901	0.1755
Size	16192	22.4472	22.257	1.366	19.9971	26.5105
Soe	16192	0.4725	0	0.4993	0	1
Tq	16192	1.9516	1.5623	1.1933	0.8504	7.7300
Lev	16192	0.48	0.4884	0.1970	0.0614	0.8843
Roa	16192	0.0351	0.0321	0.0516	-0.1839	0.1841
Cap	16192	0.2359	0.2025	0.1704	0.0023	0.7156
Liquid	16192	1.9458	1.4116	1.8822	0.2745	12.8858
Growth	16192	0.1433	0.0955	0.2221	-0.2531	1.1959
Age	16192	16.6698	17	5.6138	4	31
Law	16192	9.3429	9.292	3.0877	2.277	14.886
Fin	16192	9.2173	9.451	1.5742	4.261	11.673

4.2 An Empirical Study of the Impact of Corporate Digital Transformation on Financing Constraints

In this section, the paper examines the impact of corporate digital transformation on financing constraints and the analysis of the interaction between financial development and the legal environment on corporate digital transformation through multiple regression analysis to test the hypotheses above. The results of the model regressions are shown in Table 3. The first column of Table 3 shows the regression results of model (1). The coefficients of the interaction terms $Digital_{i,t}*Cf_{i,t-1}$ are all significantly negative at the 5% level, indicating that the digital transformation of enterprises can significantly reduce the reliance on internal cash flow for investment, i.e., the digital transformation of enterprises significantly alleviates the financing constraint, and H1 is tested. The second and third columns show the regression results of model (2) and model (3) respectively. The results show that the coefficients of the interaction terms $Fin_{i,t}*Digital_{i,t}*Cf_{i,t-1}$ and $Law_{i,t}*Digital_{i,t}*Cf_{i,t-1}$ are both significantly positive at the 1% level, while $Digital_{i,t}*Cf_{i,t-1}$ is significantly negative at the 1% level. The coefficients of $Digital_{i,t}*Cf_{i,t-1}$ are negative at the 1% level, indicating that the higher the level of financial development and the better the legal environment, the stronger the effect of digital transformation on the mitigation of financing constraints by enterprises, and H2 and H3 are verified. In addition, $Cf_{i,t-1}$ is always positive at the 1% level, indicating that firms rely on internal cash flows for investment, i.e. they are subject to external financing constraints.

Table 3 Impact of digital transformation of enterprises on financing constraints

Variables	(1)	(2)	(3)
$Digital_{i,t}$	0.0018^{***}	0.0018^{***}	0.0018^{***}
	(2.604)	(2.598)	(2.618)
$Cf_{i,t-1}$	0.124^{***}	0.126^{***}	0.129^{***}

	(5.027)	(5.109)	(5.245)
$Digital_{i,t}*Cf_{i,t-1}$	-0.0112**	-0.0958***	-0.0614***
	(-2.533)	(-3.846)	(-4.534)
$Fin_{i,t}*Digital_{i,t}*Cf_{i,t-1}$		0.0087***	
		(3.453)	
$Fin_{i,t}$		0.0003	
		(0.279)	
$Law_{i,t}*Digital_{i,t}*Cf_{i,t-1}$			0.0048***
			(3.922)
$Law_{i,t}$			-0.0005
			(-1.084)
$Lev_{i,t-1}$	-0.0623***	-0.0626***	-0.0626***
	(-11.546)	(-11.617)	(-11.609)
$Lev_{i,t-1}* Cf_{i,t-1}$	-0.0255	-0.0226	-0.0231
	(-0.773)	(-0.683)	(-0.701)
$Growth_{i,t-1}$	0.0240***	0.0239***	0.0238***
	(13.324)	(13.295)	(13.227)
$Growth_{i,t-1}* Cf_{i,t-1}$	-0.0122	-0.0127	-0.0121
	(-0.996)	(-1.035)	(-0.988)
$Age_{i,t-1}$	-0.0034*	-0.0035*	-0.0039*
	(-1.709)	(-1.730)	(-1.784)
$Age_{i,t-1}* Cf_{i,t-1}$	-0.0027***	-0.0029***	-0.0031***
	(-2.738)	(-2.992)	(-3.186)
$Liquid_{i,t-1}$	0.002***	0.002***	0.002***
	(5.064)	(5.068)	(5.060)
$Liquid_{i,t-1}* Cf_{i,t-1}$	-0.0083***	-0.0077**	-0.0076**
	(-2.694)	(-2.505)	(-2.464)
Intercept	0.0848**	0.0832**	0.0900**
	(2.171)	(2.066)	(2.296)

Ind	Control	Control	Control
Year	Control	Control	Control
N	16192	16192	16192
R^2	0.125	0.126	0.126

[a]Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

4.3 Further Discussion: The Role of Digital Transformation in Alleviating Corporate Finance Constraints Pathways

External financing for firms is usually in the form of new debt financing and new equity financing. This section draws on the approach of [13] and [14] to construct model (4) to test the impact of digital transformation further empirically on these two types of financing in order to reveal the specific path of the effect of digital transformation on the mitigation of corporate financing constraints.

$$Y_{i,t} = \beta_0 + \beta_1 Digital_{i,t} + \gamma Controls_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

The explanatory variable $Y_{i,t}$ represents the amount of financing of firm "i" in year "t". There are two main forms of financing: debt financing (*Debts*) and equity financing (*Equity*). The paper further divides new debt financing into new bank loans (*Bank*) and new bond issues (*Bond*) to specifically examine the impact of digital transformation on various types of exogenous financing constraints. The measurement of the amount of financing from each type of channel draws on [14], New bank loans (*Bank*):Increase in short-term and long-term borrowings/total assets at the beginning of the period; New bond financing (*Bond*):Increase in bonds payable/total assets at the beginning of the period; New debt financing (*Debts*):Sum of new bank loans and new bond financing, New equity financing (*Equity*):Increase in equity and Equity is measured by the increase in equity and capital surplus/total assets at the beginning of the period. Controls denote control variables, and the following variables are selected as control variables for model (4) with reference to studies by [13] and [14]: firm size (*Size*):logarithm of total assets; return on total assets (*Roa*):ratio of net profit to total assets; property rights (*Soe*): state-owned enterprises are assigned a value of "1" and non-state-owned enterprises are assigned a value of "0"; *Liquidity ratio*: total current assets/total current liabilities; *Tobin's Q*: market capitalization/total assets; *Age*: the difference between the year of observation and the year of establishment; Collateral size (*Cap*): fixed assets/total assets; Balance sheet ratio (*Lev*): total liabilities/total assets. /total assets. In addition, both industry and year fixed effects are included in the model. In model (4), the impact of digital transformation on various types of channel financing is reflected in the coefficient β_1. If β_1 is positive, it means that digital transformation can increase the corresponding amount of channel financing of the enterprise, and the specific empirical results are shown in Table 4.

As shown in Table 4, the effect of digital transformation on debt financing (*Debts*) and equity financing (*Equity*) is significantly positive at the 1% level, i.e., digital transformation can significantly increase new debt financing and new equity financing for companies. This result also reaffirms that digital transformation has a significant effect on external financing, which again confirms H1. Further dividing debt financing (*Debts*) into bank loans (*Bank*) and bond financing (*Bond*) reveals that digital transformation significantly increases bank loans but has no significant effect on bond financing, and the coefficients of new debt financing and new bank loans

The difference between the coefficients on new debt financing and new bank loans is small, suggesting that the effect of digital transformation on debt financing is mainly in terms of bank loans, rather than bond financing. It is worth noting that the coefficient of digital transformation on new equity financing is 0.0115, which is larger than the coefficient of debt financing of 0.0061, indicating that digital transformation attracts more equity financing than debt financing. This may be because digital transformation improves information asymmetry and reinforces positive market expectations, while promoting higher R&D investment and innovation output performance, as well as enhancing corporate value and financial stability, thus increasing the level of corporate equity liquidity, and attracting more equity financing for firms [1].

Table 4 A study of the pathways of digital transformation of enterprises affecting financing constraints

Variables	(1)	(2)	(3)	(4)
	$Debts_{i,t}$	**$Equity_{i,t}$**	**$Bank_{i,t}$**	**$Bond_{i,t}$**
$Digital_{i,t}$	0.0061***	0.0115***	0.0051***	0.0007
	(4.563)	(7.122)	(4.095)	(1.574)
$Size_{i,t-1}$	-0.0285***	-0.0862***	-0.0313***	0.0033***
	(-11.206)	(-28.038)	(-13.031)	(3.725)
$Roa_{i,t-1}$	0.166***	0.329***	0.128***	0.0378***
	(6.250)	(10.247)	(5.105)	(4.148)
$Lev_{i,t-1}$	-0.222***	0.303***	-0.179***	-0.0335***
	(-19.601)	(22.149)	(-16.805)	(-8.622)
$Liquid_{i,t-1}$	-0.0080***	0.0019**	-0.0053***	-0.0023***
	(-10.789)	(2.084)	(-7.583)	(-9.098)
$Soe_{i,t-1}$	-0.0138*	-0.0280***	-0.0125*	-0.0007
	(-1.920)	(-3.231)	(-1.842)	(-0.303)
$Tq_{i,t-1}$	0.0098***	0.0306***	0.0086***	0.0008*
	(6.844)	(17.660)	(6.314)	(1.682)
$Age_{i,t-1}$	0.0016	0.0010	0.0028	-0.0014
	(0.407)	(0.200)	(0.729)	(-1.038)
$Cap_{i,t-1}$	-0.122***	0.0450***	-0.109***	-0.0106***
	(-10.134)	(3.105)	(-9.594)	(-2.578)
Intercept	0.792***	1.713***	0.810***	-0.0305
	(8.281)	(14.828)	(8.986)	(-0.929)
Ind	Control	Control	Control	Control

Year	Control	Control	Control	Control
N	16192	16192	16192	16192
R^2 Adjusted	0.110	0.161	0.0987	0.0268

[a.] Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

In addition, the impact of the digital transformation of enterprises on bond financing is not significant, probably because the development of China's bond market is less developed than that of the stock market and the bank credit market, and it is more difficult for enterprises to issue bonds than to issue stocks and bank loans. It has been shown that bond financing has strong contractual rigidity, and that bond investors are more likely to resort to the law when there are problems with debt repayment, and that, all other things being equal, the risk of bankruptcy is relatively higher for firms that rely primarily on bond issuance for debt financing, and that control of the firm will shift to creditors once current debt repayment becomes problematic. Under such circumstances, firms prefer equity financing and bank loans, which are easier to achieve and less risky.

5. Robust test

Since firms with low financing constraints are themselves likely to be quality firms with better quality of development and have a greater advantage in accessing market information as well as resources, they are more likely to follow market trends in digital transformation. To address the possible endogeneity issues arising from this reverse causality, a one-period regression of the core explanatory variable digital transformation was conducted, drawing on the approach of [3], and the regression results are largely consistent with the previous results. That is, digital transformation significantly increases the debt and equity financing of firms.

Finally, a further test was conducted using PSM propensity score matching with reference to [2], where two types of enterprises were selected as the treatment and control groups based on whether the degree of digital transformation (*Digital*) of the enterprise was 0 or not. Covariations used for 1:1 match process include *Size*, return on total assets (*Roa*), nature of ownership (*Soe*), liquidity ratio (*Liquid*), Tobin's Q (*Tq*), firm age (*Age*), collateral size (*Cap*) and gearing (*Lev*), with non-repeated closest match. The results are consistent with the previous tests, indicating that the results are still robust after accounting for endogeneity.

6. Conclusion

This paper examines the impact of digital transformation of enterprises on their financing constraints, using data from A-share listed companies from 2009 to 2020 as a sample. The findings show that: (1) based on an investment-cash flow sensitivity model, digital transformation is found to significantly alleviate the financing constraints of enterprises. (2) In terms of heterogeneity, digital transformation of enterprises is more effective in alleviating their financing constraints in regions with a high degree of financial development and a good legal environment. (3) In terms of the path of action, digital transformation significantly increases new bank loans

and new equity financing, but has no significant impact on new bond financing. This result remains robust after accounting for endogeneity.

This study has important policy implications for the implementation of the Digital China strategy and the promotion of high-quality economic development: for enterprises, they should increase their sensitivity, strengthen their digital orientation, understand the impact of the development of the digital economy, actively respond to the trend of the times, seize the opportunity in time, introduce digital technology, take the initiative to transform, and make good use of digital technology to maximize the effect of digital transformation, improve their To maximize the effects of digital transformation, improve their own operational efficiency, break through the bottleneck of development, and provide new momentum for high-quality development. For the government, it needs to improve the market system, improve the legal system, help regions to improve the level of financial development and the quality of the rule of law, and create a good external environment for enterprises to carry out digital transformation, at the same time, the government can introduce relevant policies to encourage and guide enterprises to carry out digital transformation, and lower the threshold for enterprises to carry out digital transformation.

References

[1] F. Wu, H. Hu, H. Lin, and X. Ren (2021). "Enterprise digital Transformation and capital market performance -- Empirical evidence from stock liquidity." Management World, 37 (7): 130-144+10.

[2] G. Lei, R. Mai, and J. Zuo (2022). Digital transformation and capital market efficiency - based on the perspective of stock price synchronization[J]. Securities Market Herald, pp. 1-12.

[3] C. Zhao, W. Wang, and X. Li (2021). How digital transformation affects the total factor productivity of firms[J]. Finance and Trade Economics, 42 (7): 114-129.

[4] J. Zhang, J. Long (2022). Digital transformation, dynamic capabilities and firm innovation performance - empirical evidence from high-tech listed firms[J]. Economics and Management, 36 (3): 74-83.

[5] J. Hua, C. Liu, and D. Zhu (2022). Digital transformation, financing constraints and total factor productivity of firms[J]. Southern Finance, pp. 1-12.

[6] F. Jiang, B. Shi, and Y. Ma (2016). The financial experience of information publishers and corporate finance constraints[J]. Economic Research, 51(6):83-97, 2016.

[7] Fazzari S, Hubbard G, Peterson B (1988). Financing Constraints and Corporate Investment[J]. Brookings Paper on Economic Activity, no.1.

[8] H. Qi, X. Cao, and Y. Liu (2020). The impact of the digital economy on corporate governance based on information asymmetry and irrational behaviour of managers[J]. Reform, 4: 50-64.

[9] S. Yu, H. Xu, L. Kong (2022). A study on the impact of digital economy level on resource allocation efficiency of China's manufacturing industry [J/OL]. Finance and Trade Research, PP. 1-22.

[10] M. Yu, H. Zhong and R. Fan (2019). Privatization, financing constraints and firm innovation - evidence from Chinese industrial firms[J]. Financial Research, 4:75-91.

[11] Y. Cui, Y. Li, and K. Chen (2017). Government governance, financial development and surplus quality improvement[J]. Systems Engineering, 35(10):1-12.

[12] X. Wang, G. Fan, and J. Yu (2021). China marketization index report by provinces (2021) [M]. Beijing: Social Science Literature Press.

[13] C. Wu, S. Wu, J. Cheng and L. Wang (2012). An empirical study on the impact of venture capital on the investment and financing behavior of listed companies[J]. Economic Research, 47(1):105-119+160.
[14] X. Han, G. Tian and J. Li (2017). Shadow banking and financing structure of non-financial firms - empirical evidence from Chinese listed companies [J]. International Financial Studies, 10:44-54.