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*Research article*

# Does digital transformation of enterprises help reduce the cost of equity capital

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**Abstract:** Digital economy is regarded as the main economic form following agricultural economy and industrial economy. And the digital transformation has given enterprises new development momentum. Can it reduce the equity capital cost? This paper uses text analysis obtained by crawling the annual reports from 2010 to 2021 and investigates the impact of digital transformation on the corporate equity capital cost. The results show that: 1) Digital transformation will reduce the equity capital cost; 2) The digital transformation has a heterogeneous impact on the equity capital cost of enterprises with different scales, natures and levels of leverage, which is more significant for large-scale enterprises, state-owned enterprises and highly leveraged enterprises; 3) Digital transformation mainly affects the equity capital cost by improving enterprise value, rather than by increasing analysts' attention and influencing the level of corporate risk bearing.

**Keywords:** enterprise digital transformation; equity capital cost; text analysis

## 1. Introduction

Digital economy is regarded as the main economic form following agricultural economy and industrial economy. In particular, COVID-19 is a catalyst for the application and promotion of digital technology in the workplace [1–3]. The digital economy takes the modern information network as the main carrier, and the digital transformation of elements and the comprehensive application of communication technology as the important driving force [4]. For example, digital finance is the product of the combination of digital economy and traditional finance [5], which can alleviate the

constraint of insufficient development of traditional finance on enterprise performance [6,7]. Therefore, digital transformation may be beneficial to the improvement of enterprise performance. This is mainly because the digital transformation has given enterprises new development momentum. Enterprises use digital technology to obtain resources and transfer information. Digital resources include artificial intelligence, big data, cloud computing, etc. The integration and application of these technical resources within the enterprise will help improve the production efficiency of the enterprise. Digitalization can also improve the efficiency of information transmission of enterprises, promote the "cloud" of enterprise business, and quickly show various enterprise management data to stakeholders through big data analysis technology, which is conducive to the realization of enterprise value. Hess et al. [8] believed that enterprises must use digital transformation to innovate, so as to obtain better operational performance. In a word, the role of digital transformation is uncertain. For one thing, digital transformation can reduce the information asymmetry, enhance enterprise value, and reduce the equity capital cost. For another, the digital transformation will make enterprises' business more complex and increase the information asymmetry, reducing enterprise performance [9], thus increasing the equity capital cost.

Enterprises' equity capital cost will affect their financing decision, and then the investment decision (because the financing and investment decisions of enterprises are closely linked [10–12]). Scholars also found that good corporate governance, high-quality information disclosure and corporate social responsibility can improve corporate performance [13–15], and reduce the equity capital cost. Then naturally the problem arises. Can enterprises voluntarily carry out digital transformation to reduce the equity capital cost? Digital transformation may reduce the equity capital cost. This is because: digital transformation can improve the information environment of the capital market. Chen et al. [16] found that after the enterprises implemented digital transformation, analysts' attention has increased significantly, which will improve the information disclosure quality significantly. Furthermore, high-quality information disclosure helps to reduce the equity capital cost. Enterprises with higher financial transparency face lower equity capital cost [17].

This research is mainly related to three branches of literatures: Firstly, it is related to the research on digital transformation and enterprise production efficiency. The role of digital transformation in promoting enterprise value and performance has been recognized by most scholars [18]. For one thing, digital transformation can improve production efficiency and reduce production costs; For another, digital transformation can also promote enterprise innovation [19]. The study also found that the digital economy can stimulate entrepreneurship [20–22]. Secondly, it is related to the research on corporate governance and equity capital cost. Relevant research results show that effective corporate governance, especially strict disclosure standards, can reduce the cost of corporate equity capital by reducing agency costs and information asymmetry [23–26]; Fulfilling corporate social responsibility can enhance corporate value [27,28], and can also reduce the equity capital cost [29]. On the contrary, poor corporate governance will increase the equity capital cost. For example, the controlling shareholder's equity pledge increases the equity capital cost by increasing information risk and agency conflict [30]. The fierce product market competition will reduce the equity capital cost [31]. Thirdly, it is related to the research on information asymmetry and equity capital cost. Enterprises reduce information asymmetry among investors mainly through information disclosure and information intermediary. Many scholars have demonstrated that good information disclosure can reduce equity capital. They believe that the higher the complexity of the annual report, the higher the equity capital cost [32]; Enterprises with good reputation often enjoy lower equity capital cost [33]. Therefore, enterprises can often reduce the equity capital cost by issuing high-quality social

responsibility reports [34]. Dhaliwal et al. [35] also found that voluntary corporate social responsibility information disclosure is conducive to reducing the equity capital cost. However, the research on the equity capital cost by information intermediaries (including analysts) is still limited. According to Merton [36]'s research, analysts' attention can increase investors' awareness of the enterprise, reduce information asymmetry among investors, and thus reduce the equity capital cost. However, Zhang [37] believed that financial analysts' access to information could benefit more informed investors, and actually increased the degree of information asymmetry. In addition, analysts' own conflicts of interest also affect their ability to reduce information asymmetry [38]. Therefore, whether analysts can reduce the equity capital cost remains to be empirically tested.

The main contributions of our paper are as follows: 1) This is the first study on the effect of digital transformation on the equity capital cost to the best of our knowledge. This paper uses the annual report data to describe the degree of digital transformation and empirically test the impact of digital transformation on the equity capital cost. The results show that digital transformation can significantly reduce the equity capital cost. 2) Further investigate the impact of digital transformation for different types of enterprises. This paper further distinguishes between the large-scale and the small and medium-sized, the state-owned and the private, as well as the high leverage and the low leverage, and examines the role of digital transformation of different types of enterprises. The results show that digital transformation has a greater impact on the equity capital cost of large-scale enterprises, state-owned enterprises and highly leveraged enterprises. 3) Expand the research on information asymmetry and equity capital cost [24]. Previous studies only focused on the impact of information disclosure on the equity capital cost, and paid less attention to the impact of information intermediaries (such as analysts) on the equity capital cost. This paper examines the mechanism of digital transformation affecting the equity capital cost from the perspectives of analysts' concerns, enterprise value and enterprise risk bearing. The results show that digital transformation mainly reduces the equity capital cost of enterprises by increasing the value of enterprises, rather than by increasing the attention of analysts and influencing the level of enterprise risk bearing.

The rest of the paper is structured as follows: The second part is the research design, including: describing the model used, main variables and data sources, and carrying out descriptive statistics for the main variables; The third part carries out empirical test, including: empirical test of the impact of enterprise digital transformation on the equity capital cost, further study of the impact of heterogeneity and the impact mechanism; The fourth part carries out robustness test, including: replacing the explained variable and explanatory variable and considering endogenous problems; The fifth part summarizes the full text.

## 2. Research design

### *2.1. Model*

In order to empirically test the impact of enterprise digital transformation on the equity capital cost, this paper sets a panel fixed effect model:

$$COC_{it} = \beta_0 + \beta_1 digital_{it} + \sum \beta_s CVs + \sum Year + \sum Ind + \varepsilon_{it} \tag{1}$$

Among them, the explained variable is the equity capital cost ($COC_{it}$), the core explanatory variable is digital transformation($digital_{it}$), $\beta_1$ is the coefficient we care about, which is expected to

be negative. $CVs$ include a series of control variables and $\varepsilon_{it}$ is the random disturbance term. In the model, year fixed effect $\sum Year$ and industry fixed effect $\sum Ind$ are also controlled to exclude the impact of time trend and industry factors.

To investigate the impact mechanism of enterprise digital transformation on the equity capital cost, this paper constructs a panel mediation effect model:

$$Mediator_{it} = \beta_0 + \beta_1 digital_{it} + \sum \beta_s CVs + \sum Year + \sum Ind + \varepsilon_{it} \tag{2}$$

$$COC_{it} = \beta_0' + \beta_1' digital_{it} + \beta_2' Mediator_{it} + \sum \beta_s' CVs + \sum Year + \sum Ind + \varepsilon_{it}' \tag{3}$$

Among them, $Mediator_{it}$ is the mediation variable. The calculation process of this model includes two steps: the first is to use intermediary variables to regress enterprises' digital transformation; the second is to use the equity capital cost to regress the intermediary variables and enterprises' digital transformation.

### *2.2. Main variables and data sources*

The explanatory variable is the equity capital cost, the core explanatory variable is the digital transformation, and the control variables at the enterprise level are also added. In addition, three types of intermediary variables are investigated.

#### 2.2.1. Cost of equity capital (COC)

We mainly use PEG model to estimate the equity capital cost, and then use MPEG model and OJ model to test the robustness of the estimated results.

Easton [39] proposed the PEG and MPEG model based on PE Ratio and PEG Ratio, respectively. These models assume there is an expected rate of change $\Delta agr$ and $\Delta agr = (agr_{t+1} / agr_t) - 1$ for $agr_t$ (the growth rate of abnormal returns).

PEG model assumes that $\Delta agr$ is constant and equals zero, and we get:

$$RE_{PEG} = \sqrt{(eps_2 - eps_1) / P_0} \tag{4}$$

$eps_1$ and $eps_2$ denotes the earnings per common share at the steps 1 and 2. $P_0$ denotes the stock price at the Initial step.

MPEG model assumes that the growth rate of abnormal returns remains unchanged.

$$RE_{MPEG} = dps_1 / P_0 + \sqrt{(eps_2 + dps_1 - eps_1) / P_0} \tag{5}$$

Among them, $dps_1 = eps_1 * \delta$, $\delta$ refers to the average dividend payment rate in the past three years.

Ohlson and Juettner-Nauroth [40] proposed the OJ model. The equals of the model is as follows:

$$RE_{OJ} = A + \sqrt{A^2 + \frac{eps_1 * (g_2 - (r-1))}{P_0}} \tag{6}$$

Among them, $A = 0.5 * [(r-1) + \frac{dps_{t+1}}{P_t}]$, $g_2 = \frac{eps_2 - eps_1}{eps_1}$, $dps_1 = eps_1 * \delta$, $g_p = r - 1$ denotes the

growth rate of earnings per common share which reflects the average growth rate of the whole economy in a relatively long period. This value is assumed as 5%.

#### 2.2.2. Enterprise digital transformation

We mainly use methods representing enterprise digital transformation awareness to measure enterprise digital transformation, due to the lack of measurement indicators for digital transformation behavior. Referring to the research of Jiang et al. [41] and Wu et al. [42], the method of text analysis is used to measure the digital transformation. Specifically, we search, match and count the word frequency by key words, and then classify and collect the word frequency of key technical directions to form the final aggregated word frequency, so as to build an indicator system for the digital transformation of enterprises.

Referring to the research of Wu, Fu and Kong [42], the vocabulary of enterprise digital transformation includes five aspects: 1) artificial intelligence technology. 2) Big data technology. 3) Cloud computing technology. 4) Blockchain technology, which includes Blockchain Digital currency [43–45], Distributed Computing and so on. 5) Application of digital technology [46,47].

#### 2.2.3. Control variable

Referring to the research of El Ghoul et al. [48], we mainly select the control variables that affect the equity capital cost. These control variables include: enterprise size, ownership concentration (h10), state ownership, enterprise growth capacity, enterprise size, enterprise profitability (roa), enterprise asset structure (asset_li), etc. The data is from the China Stock Market & Accounting Research (CSMAR) database.

#### 2.2.4. Intermediary variable

Considering that the digital transformation of enterprises may be able to reduce the equity capital cost of enterprises by attracting the attention of analysts, improving the value of enterprises [18], or improving the level of enterprise risk bearing [49]. Therefore, this paper selects three types of intermediary variables: first, analysts' attention. Analyst = ln (1+number of analysts tracking). Second, enterprise value. Tobin Q is used to measure enterprise value. Third, operational risk.

Referring to the research of Tian, Li and Cheng [49], John et al. [50] and Boubakri et al. [51], this paper adopts two methods to measure the company's operational risk: RISK1 is equal to the standard deviation of the industry adjusted ROA of each enterprise in each observation period, and RISK2 is equal to the difference between the maximum and minimum ROA adjusted by the industry in each enterprise sample period. The specific calculation is as follows:

$$RISK1_{it} = \sqrt{\frac{1}{N-1}\sum_{n=1}^{N}(ADJ\_ROA_{in} - \frac{1}{N}\sum_{n=1}^{N}ADJ\_ROA_{in})^2 \,|\, N=3} \tag{7}$$

$$RISK2_{it} = Max(ADJ\_ROA_{in}) - Min(ADJ\_ROA_{in}) \tag{8}$$

$$\text{Among them, } ADJ\_ROA_{in} = \frac{EBIT_{in}}{ASSET_{in}} - \frac{1}{X_n}\sum_{k=1}^{X}\frac{EBIT_{in}}{ASSET_{in}} \tag{9}$$

$ADJ\_ROA_{in}$ denotes ROA adjusted by the industry in each enterprise sample period. In Eq (9), $EBIT_{in}$ is the profit before interest and tax. $ASSET_{in}$ is the year-end asset balance.

See Table 1 for the relevant definitions of the above variables.

**Table 1.** The definition of main variables.

| Variable | Name | Definition |
|---|---|---|
| Explained Variable | Cost of equity capital (COC) | Calculated by PEG model |
| Explanatory variable | Enterprise digital transformation (digital) | Ln(1+ Word frequency of enterprise digital transformation) |
| Control variable | Enterprise scale (size) | Natural logarithm of year-end asset balance |
| | ownership concentration (h10) | The ratio of top ten shareholders |
| | Proportion of state-owned shares (stateown) | The ratio of state-owned shares |
| | Enterprise growth ability (incomerate) | Growth rate of operating income |
| | Profitability (roa) | Return on assets |
| | Enterprise asset structure (asset_li) | Asset liability ratio |
| Intermediary variable | Information asymmetry (analyst) | Ln (1+ Number of analyst concerns) |
| | Enterprise value (Tobin Q) | Tobin Q |
| | Business risk (Risk1） | Industry adjusted standard deviation of ROA |

Considering that most Chinese enterprises began their digital transformation only in 2010, we select the data of A-share listed companies from 2010 to 2021. After collecting the data, the following processes were carried out: First, as the financial statements of financial enterprises differ greatly from those of non-financial enterprises, we exclude the financial enterprises from our samples; Second, since the profits of enterprises marked by ST(Special Treated) are negative in recent two consecutive years, which make them very different from general enterprises, these enterprises are eliminated; Third, in order to avoid the impacts of outliers, we winsorize continuous variables at the 1 and 99% level. Fourth, companies with obviously unreasonable data were excluded, such as the samples with the top ten shareholders holding more than 100% of the shares. In addition to the data of digital transformation, other data are all from CSMAR Database, and relevant enterprise annual report data are from the information disclosure website designated by China Securities Regulatory Commission.

### *2.3. Descriptive statistics*

Before the specific empirical analysis, we conducted a preliminary statistical calculation and correlation analysis on the explanatory variables.

Table 2 shows that the degree of digital transformation for Chinese enterprises is still low, and the profitability of enterprises is weak due to the relatively high equity capital cost. Specifically, the minimum and maximum value of the equity capital cost are 0 and 0.56, respectively, with an average

of 0.11, indicating that the average equity capital cost of Chinese listed enterprises is 11%. The minimum and maximum values of digital transformation are 0 and 6.29 respectively, and the average value is 1.17, indicating that the degree of digital transformation of most enterprises is low. The average asset liability ratio is 0.41, which is greater than the standard deviation of 0.2; The average enterprise size is 22.4, which is greater than the standard deviation of 1.38, indicating that the enterprise size and debt level are relatively concentrated. The average of net asset interest rate is 0.05, indicating that the profitability of the enterprise is weak on the whole. The average shareholding ratio of the top ten shareholders is 61.12%, indicating that the enterprise's equity concentration is generally high, reaching 61.12% on average.

**Table 2**. Descriptive statistics.

| Variable | Number of samples | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| COC | 21,204 | 0.11 | 0.04 | 0.00 | 0.56 |
| digital | 21,204 | 1.17 | 1.46 | 0 | 6.29 |
| size | 21,204 | 22.40 | 1.38 | 15.98 | 28.64 |
| roa | 21,204 | 0.05 | 0.07 | -3.91 | 2.64 |
| asset_li | 21,204 | 0.41 | 0.200 | 0.05 | 0.86 |
| stateown | 21,204 | 0.04 | 0.130 | 0 | 0.92 |
| incomerate | 21,195 | 0.22 | 0.370 | -0.42 | 2.26 |
| h10 | 21,204 | 61.12 | 14.75 | 12.71 | 98.59 |

**Table 3.** Correlation analysis of main variables.

| | COC | digital | size | roa | asset_li | stateown | incomerate | h10 |
|---|---|---|---|---|---|---|---|---|
| COC | 1 | | | | | | | |
| digital | -0.0727* | 1 | | | | | | |
| size | 0.1597* | 0.0311* | 1 | | | | | |
| roa | -0.0582* | -0.0098 | -0.0940* | 1 | | | | |
| asset_li | 0.2248* | -0.0553* | 0.5756* | -0.3260* | 1 | | | |
| stateown | -0.0338* | -0.0754* | 0.1298* | -0.0098 | 0.0853* | 1 | | |
| incomerate | 0.0445* | 0.0226* | -0.0063 | 0.1583* | 0.0483* | 0.0449* | 1 | |
| h10 | -0.0484* | -0.0737* | 0.0830* | 0.1534* | -0.0958* | 0.1787* | 0.0551* | 1 |

Table 3 shows that there is a significant negative correlation between the explained variable COC and the core explanatory variable digital, which preliminarily confirms the role of enterprise digital transformation in the equity capital cost. The correlation coefficient between the explanatory variables is low, indicating that there is no strong correlation between the explanatory variables. We also find that there is a significant correlation between the proportion of state-owned shares, growth capacity income and the proportion of the top ten shareholders and the cost of equity capital (COC), indicating that the larger the enterprise size, strong profitability, high asset liability ratio, low proportion of state-owned shares, strong growth capacity, and low proportion of the top ten shareholders, the higher the equity capital cost.

## 3. Research design

### *3.1. Benchmark regression*

First, we use the panel fixed effect model to test the impact of enterprise digital transformation on the equity capital cost. The results are shown in Table 4, where: control variables and year fixed effects are added in column (1), and industry fixed effects are further controlled in column (2).

**Table 4.** The effect of Digital transformation on the equity capital cost.

| | (1)<br>COC | (2)<br>COC |
|---|---|---|
| digital | -0.0012*** | -0.0009*** |
| | (-4.73) | (-3.26) |
| size | 0.0026*** | 0.0030*** |
| | (6.30) | (8.09) |
| roa | -0.0043 | -0.0079 |
| | (-0.86) | (-1.55) |
| asset_li | 0.0349*** | 0.0263*** |
| | (13.40) | (11.14) |
| stateown | -0.0229*** | -0.0157*** |
| | (-8.20) | (-6.02) |
| incomerate | 0.0048*** | 0.0035*** |
| | (5.81) | (4.47) |
| h10 | -0.0002*** | -0.0001*** |
| | (-5.60) | (-5.48) |
| Year FE | √ | √ |
| Industry FE | | √ |
| *N* | 21195 | 21194 |
| adj. $R^2$ | 0.181 | 0.237 |

Note: t value after clustering adjustment at the enterprise level is shown in brackets, *, ** and *** indicate significant at 10, 5 and 1%.

According to Table 4, the digital transformation of enterprises will reduce the equity capital cost. Specifically, the coefficients in front of the enterprise digital transformation variables in columns (1) and (2) are significant, and their value are -0.0012 and -0.0009, respectively, indicating that enterprise digital transformation can reduce the equity capital cost, which confirms the main research conclusions of this paper. In addition, the coefficient in front of the three variables in columns (1) and (2), namely, enterprise scale, asset liability ratio, and operating income growth rate, is significantly positive, indicating that enterprises with larger size, higher leverage ratio, and stronger growth ability will expend higher equity capital cost. The coefficient in front of the proportion of state-owned shares and the shareholding proportion of the top ten shareholders is significantly negative, indicating that enterprises with higher state-owned shares and higher equity concentration will expend lower equity capital cost.

### *3.2. Heterogeneous effects*

According to previous studies [52–55], enterprises with different sizes, enterprise nature and asset structure often show different characteristics of digital transformation or capital cost: first, we compare the large-scale with the small and medium-sized. Compared with the small and medium-sized, the large-scale have better resource endowment, so they are more motivated, or more accurately, more capable, to carry out digital transformation. Second, we compare the state-owned with the non-state-owned. The state-owned have natural advantages in resource acquisition, market occupation and other fields by virtue of their embedded advantages in the national credit chain [56]. Such enterprises often face less market competition pressure, and lack motivation for innovation and digital transformation. They pay relatively little attention to the front digital technology, and lack strong will to promote digital transformation. On the contrary, non-state-owned enterprises are faced with the intense market competition, so they are willing to invest more in transformation activities in order to obtain more market share. Third, we compare high leverage enterprises with low leverage enterprises. The equity capital cost of highly leveraged enterprises is high. In order to reduce the equity capital cost, highly leveraged enterprises may be more willing to carry out digital transformation in order to reduce their equity capital cost. Therefore, we analyze the heterogeneity from three aspects: enterprise scale, enterprise nature and leverage level.

**Table 5.** The heterogeneity effect of enterprise digital transformation on the equity capital cost.

| | (1) Large scale | (2) Small and medium-sized | (3) State-owned | (4) Non-state-owned | (5) Highly leveraged | (6) Low leverage |
|---|---|---|---|---|---|---|
| digital | -0.0012*** | -0.0007* | -0.0015*** | -0.0011*** | -0.0013** | -0.0008** |
| | (-2.90) | (-1.87) | (-2.89) | (-3.20) | (-2.30) | (-2.35) |
| size | 0.0013** | 0.0070*** | 0.0057*** | 0.0037*** | 0.0036*** | 0.0024*** |
| | (2.10) | (8.86) | (9.25) | (6.86) | (6.29) | (5.21) |
| roa | -0.0089 | -0.0078 | 0.0154 | -0.0130** | -0.0111 | 0.0009 |
| | (-0.91) | (-1.27) | (1.51) | (-2.10) | (-1.32) | (0.12) |
| asset_li | 0.0346*** | 0.0139*** | 0.0322*** | 0.0261*** | 0.0471*** | 0.0220*** |
| | (9.34) | (4.79) | (8.00) | (9.09) | (6.05) | (6.66) |
| stateown | -0.0109*** | -0.0230*** | -0.0003 | -0.0115 | -0.0071 | -0.0198*** |
| | (-3.26) | (-6.09) | (-0.10) | (-1.01) | (-1.56) | (-7.03) |
| incomerate | 0.0022** | 0.0046*** | 0.0010 | 0.0029*** | 0.0022* | 0.0044*** |
| | (2.06) | (3.98) | (0.68) | (3.08) | (1.74) | (4.20) |
| h10 | -0.0002*** | -0.0001 | -0.0003*** | -0.0001*** | -0.0002*** | -0.0001*** |
| | (-6.06) | (-1.64) | (-6.06) | (-4.81) | (-3.81) | (-4.92) |
| Year FE | √ | √ | √ | √ | √ | √ |
| Industry FE | √ | √ | √ | √ | √ | √ |
| *N* | 10461 | 10463 | 7629 | 13292 | 7252 | 13671 |
| adj. $R^2$ | 0.251 | 0.226 | 0.272 | 0.243 | 0.242 | 0.196 |

Note: t value after clustering adjustment at the enterprise level is shown in brackets, *, ** and *** indicate significant at 10, 5 and 1%.

Based on this, these samples are classified into three different groups: according to the quantile

of enterprise size, enterprises are divided into the large-scale and the small and medium-sized; According to the nature, enterprises are divided into the state-owned and the private; According to whether the asset liability ratio of enterprises is greater than 50%, enterprises are divided into the high leverage and the low leverage. Then the panel fixed effect model is used to analyze the heterogeneous impact of digital transformation on the equity capital cost. We examine the heterogeneous impact of enterprises of different sizes, natures and leverage in Table 5, respectively.

Table 5 shows that as for enterprises with different sizes, natures and leverages, the impacts of digital transformation on the equity capital cost are heterogeneous. For large-scale enterprises, state-owned enterprises and highly leveraged enterprises, their digital transformations have greater impacts. Specifically, in columns (1)–(6) the coefficients in front of digital transformation have passed the 1% significance test; The absolute values (0.0012, 0.0015 and 0.0013) of the coefficients in front of the digital transformation in columns (1), (3) and (5) are greater than those in columns (2), (4) and (6) (0.0007, 0.0011 and 0.0008) respectively. It indicates that, compared with small and medium-sized enterprises, private enterprises and low leverage enterprises, the impacts of large-scale enterprises, state-owned enterprises and high leverage enterprises are greater. The reason may lie in: for enterprises with different sizes and natures, large-scale enterprises and state-owned enterprises are more likely to be concerned [54], so their digital transformation will bring greater impact, and thus affect the equity capital cost; For enterprises with different leverage, it may be that the equity capital cost of highly leveraged enterprises deviates more from the risk-free interest rate, which makes the digital transformation have a greater impact on the equity capital cost.

### *3.3. Impact mechanism*

Furthermore, this paper uses the panel mediation effect model to investigate the mechanism of digital transformation affecting the equity capital cost. According to the previous analysis, the intermediary variables analyzed in this paper mainly include analyst concern, enterprise value and enterprise risk bearing level. The specific regression results are shown in Table 6.

Table 6 shows that the digital transformation of enterprises will mainly affect the equity capital cost by increasing the value of enterprises and reducing the equity capital cost, rather than by attracting analysts' attention and increasing the risk bearing of enterprises. Specifically, the coefficient in front of the analyst concern variable in column (1) of Table 6 is 0.0391, and is significant, indicating that enterprise digital transformation helps to increase analyst concern; In column (2), the coefficients in front of analysts' attention and digital transformation are 0.0021 and -0.0010 respectively, and are both significant, indicating that digital transformation will increase analysts' attention, but this will increase the equity capital cost. This confirms the research conclusion of Zhang [37]. For Chinese listed companies, although digital transformation has successfully attracted the attention of financial analysts, the result of such attention is that financial investment analysts gain information to benefit informed investors, which actually increases the information asymmetry among investors. The coefficient in front of the digital transformation variable in column (3) is 0.0366, and is significant, indicating that digital transformation is helpful to improve enterprise value; The coefficients in front of the digital transformation and the enterprise value in column (4) are -0.0007 and -0.0054 respectively, and are both significant, indicating that the digital transformation will reduce the equity capital cost by improving the enterprise value. The coefficients in front of digital transformation and enterprise risk bearing level in columns (5) and (6)

are not significant, indicating that digital transformation cannot affect the equity capital cost by affecting the enterprise risk bearing level.

**Table 6.** The intermediary effect of enterprise digital transformation on equity capital cost.

| | (1) analyst | (2) COC | (3) Tobin Q | (4) COC | (5) Risk1 | (6) COC |
|---|---|---|---|---|---|---|
| digital | 0.0391*** | -0.0010*** | 0.0366*** | -0.0007*** | -0.0006 | -0.0006 |
| | (5.09) | (-3.57) | (3.21) | (-2.58) | (-0.80) | (-1.06) |
| size | 0.3613*** | 0.0024*** | -0.2608*** | 0.0016*** | 0.0008 | 0.0049*** |
| | (35.00) | (5.91) | (-16.15) | (4.48) | (0.90) | (6.06) |
| roa | 2.5922*** | -0.0123** | 2.8860*** | 0.0090 | -0.0032 | 0.0008 |
| | (5.09) | (-2.20) | (3.70) | (1.59) | (-0.41) | (0.08) |
| asset_li | -0.7302*** | 0.0273*** | -0.1620 | 0.0251*** | -0.0018 | 0.0232*** |
| | (-8.74) | (11.49) | (-1.32) | (10.83) | (-0.34) | (4.87) |
| stateown | -0.3795*** | -0.0148*** | -0.4752*** | -0.0184*** | -0.0054 | -0.0091* |
| | (-6.12) | (-5.68) | (-8.44) | (-7.03) | (-1.00) | (-1.82) |
| h10 | 0.0017** | -0.0001*** | -0.0053*** | -0.0002*** | -0.0001 | -0.0001** |
| | (2.36) | (-5.65) | (-5.32) | (-6.76) | (-1.18) | (-2.07) |
| incomerate | 0.1409*** | 0.0034*** | 0.1312*** | 0.0043*** | 0.0034** | -0.0002 |
| | (6.29) | (4.26) | (4.22) | (5.39) | (2.40) | (-0.11) |
| analyst | | 0.0021*** | | | | |
| | | (4.83) | | | | |
| Tobin Q | | | | -0.0054*** | | |
| | | | | (-21.24) | | |
| Risk1 | | | | | | 0.0135 |
| | | | | | | (0.76) |
| Year FE | √ | √ | √ | √ | √ | √ |
| Industry FE | √ | √ | √ | √ | √ | √ |
| *N* | 20927 | 20927 | 20607 | 20607 | 5165 | 5165 |
| adj. $R^2$ | 0.290 | 0.239 | 0.330 | 0.256 | 0.029 | 0.254 |

Note: t value after clustering adjustment at the enterprise level is shown in brackets, *, ** and *** indicate significant at 10, 5 and 1%.

## 4. Robust checks

Finally, to ensure the robustness of the regression results, we re-estimate the model by replacing the explained variable, replacing the explanatory variable and considering the endogeneity.

### *4.1. Replace interpreted variable*

First, we re-estimated the equity capital cost using MPEG model and OJ model.

From Table 7, it can be concluded that digital transformation can reduce the equity capital cost, no matter whether the MPEG method or OJ method is used to measure the equity capital cost. Specifically, the coefficients in front of the digital transformation variables in columns (1) and (2) are -0.0011 and -0.0007, respectively, and both pass the 1% significance test, indicating that the

original conclusions can still be drawn by using other measurement methods.

**Table 7.** Replace interpreted variable.

| | (1) MPEG | (2) OJ |
|---|---|---|
| digital | -0.0011*** | -0.0007** |
| | (-2.76) | (-2.27) |
| size | 0.0074*** | 0.0032*** |
| | (14.33) | (7.71) |
| roa | 0.0082 | -0.0105* |
| | (0.99) | (-1.68) |
| asset_li | 0.0094*** | 0.0184*** |
| | (3.15) | (7.58) |
| stateown | -0.0262*** | -0.0202*** |
| | (-8.65) | (-7.78) |
| incomerate | -0.0009 | 0.0026*** |
| | (-0.98) | (3.20) |
| h10 | -0.0001*** | -0.0001*** |
| | (-3.17) | (-4.14) |
| Year FE | √ | √ |
| Industry FE | √ | √ |
| *N* | 20422 | 20422 |
| adj. $R^2$ | 0.259 | 0.216 |

Note: t value after clustering adjustment at the enterprise level is shown in brackets, *, ** and *** indicate significant at 10, 5 and 1%.

### *4.2. Replace explaining variable*

Furthermore, we set the dummy variable of whether the enterprise conducts digital transformation (isdigital) to analyze whether the enterprise's digital transformation can reduce the equity capital cost.

**Table 8.** Replace explaining variable.

| | (1) PEG | (2) PEG |
|---|---|---|
| digital | | -0.0008* |
| | | (-1.91) |
| isdigital | -0.0014** | |
| | (-1.97) | |
| size | 0.0031*** | 0.0071*** |
| | (8.13) | (7.03) |
| roa | 0.0010 | -0.0102* |
| | (0.17) | (-1.67) |

*Continued on next page*

| | (1)<br>PEG | (2)<br>PEG |
|---|---|---|
| asset_li | 0.0258*** | 0.0201*** |
| | (10.92) | (5.54) |
| stateown | -0.0158*** | 0.0039 |
| | (-6.02) | (1.21) |
| incomerate | 0.0031*** | -0.0002 |
| | (3.92) | (-0.18) |
| h10 | -0.0001*** | -0.0002*** |
| | (-5.68) | (-4.13) |
| Year FE | √ | √ |
| Industry FE | √ | √ |
| Individual FE | | √ |
| *N* | 20422 | 20764 |
| adj. $R^2$ | 0.252 | 0.365 |

Note: t value after clustering adjustment at the enterprise level is shown in brackets, *, ** and *** indicate significant at 10, 5 and 1%.

Table 8 shows that whether the enterprise conducts digital transformation is taken as an explanatory variable, and we can still conclude that digital transformation can reduce the equity capital cost. Specifically, the coefficient in front of isdigital is -0.0014 and is significant, which indicates that enterprises can reduce the equity capital cost through digital transformation.

### *4.3. Endogeneity*

The main sources of endogeneity are two-way causality, omission of important explanatory variables and selection bias [57].

#### 4.3.1. Control individual fixed effect

Our model may also have endogenous problems caused by missing important explanatory variables. So as to solve this endogenous problem, we further controlled individual fixed effects in the model. It reveals that the coefficient in front of the enterprise digital transformation variable is still significant, which further confirms that the determination of digital transformation can reduce the equity capital cost.

#### 4.3.2. Instrumental variable method

The low cost of capital may drive enterprises to make digital transformation. In order to deal with possible endogenous problems, we adopt panel tool variable method. Drawing on the research of Zhai et al. [58], we selected the dummy variable "whether the enterprise is located in the key city of digital transformation" (City). The key cities of digital transformation mainly include Beijing, Shanghai, Guangzhou, Shenzhen, Hangzhou, Suzhou, Nanjing, Wuhan, Zhuhai and Xiamen. We expect that enterprises located in these key cities n will have a higher degree of digital transformation. So we believe that there is a significant correlation between the City variable and the digital variable,

but there is no direct correlation with the equity capital cost, that is, the tool variable meets the exogenous conditions and correlation conditions.

**Table 9.** Regression results of instrumental variables

| | (1) | (2) |
|---|---|---|
| | digital | PEG |
| City | 0.1474*** | |
| | (4.10) | |
| digital | | -0.0131** |
| | | (-2.11) |
| size | 0.1220*** | 0.0047*** |
| | (8.46) | (5.40) |
| roa | -0.2575* | -0.0099* |
| | (-1.67) | (-1.77) |
| asset_li | -0.1106 | 0.0241*** |
| | (-1.17) | (8.82) |
| stateown | -0.2174*** | -0.0187*** |
| | (-2.67) | (-5.96) |
| incomerate | 0.0811*** | 0.0045*** |
| | (3.20) | (4.56) |
| h10 | -0.0021** | -0.0001*** |
| | (-2.19) | (-4.92) |
| Year fixed effect | Controlled | Controlled |
| Industry fixed effect | Controlled | Controlled |
| *N* | 21253 | 21253 |
| Cragg-Donald Wald F statistic | 16.77(P value is 0.000) | |

Note: t value after clustering adjustment at the enterprise level is shown in brackets, *, ** and *** indicate significant at 10, 5 and 1%.

Table 9 shows that using the panel tool variable model, the digital transformation of enterprises has a significant impact on the equity capital cost. Specifically, the coefficient in front of the City variable in the regression results of the first stage was 0.1474, and is significant; The statistical value of Cragg Donald Wald F is 16.77, which rejects the original assumption that City is a weak tool variable; In the second stage of regression, the coefficient in front of digital is significant and the value is -0.0131, which confirms that the determination of digital transformation can reduce the equity capital cost.

## 5. Conclusions

Digital technology has given enterprises new impetus for development and changed the traditional production and exchange methods. Digital transformation has given enterprises new development momentum. Enterprises can use digital technology to obtain digital technology resources and transfer information. The equity capital cost will affect the financing and investment decisions of enterprises. Can digital transformation reduce the equity capital cost? This has become a scientific problem to be tested. We use text analysis to measure the digital transformation, and examines

the impact of digital transformation on the equity capital cost. The main conclusions are as follows:

Firstly, the digital transformation will reduce the equity capital cost. The reason may be twofold, one of which may be that digital transformation can improve the information environment of the capital market, and high-quality information disclosure helps to reduce the equity capital cost. The other may be that digital transformation can improve the enterprise value, thus reduce the equity capital cost. Secondly, digital transformation has heterogeneous impacts on the equity capital cost of enterprises with different sizes, natures and leverages, which is reflected in a greater impact on the large-scale, the state-owned and the highly leveraged. Furthermore, our empirical results have supported that digital transformation mainly affects the equity capital cost by improving enterprise value, not by strengthening analysts' attention and influencing the level of enterprise risk bearing. Finally, we have also checked the robustness of the regression results, we re-estimate the model by replacing the explained variable, replacing the explanatory variable and considering the endogeneity. The conclusion is still valid, which further proves that digital transformation can indeed reduce the equity capital cost.

The conclusion is of great significance to enterprise managers. It shows that managers can reduce the equity capital cost by implementing digital transformation. However, when considering whether to implement digital transformation, managers need to consider the actual situation of the enterprises, such as the size, natures and leverage. The analysis of this paper shows that for the large-scale, the state-owned enterprises and the high leverage, the effect of digital transformation is more significant.

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## Conflict of interest

The authors declare there is no conflict of interest.

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