

# Digital Technology Innovation, Digital Transformation and Enterprise Value

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**Abstract:** Under the background of digital economy, the acceleration of digital technology innovation has increasingly become the important forces to change the pattern of world competition, and the effect of digital technology innovation on enterprise value is also the focus of academic research. Basis on that, this paper takes China's A-share listed companies from 2011 to 2022 as the research object to explore the effect of digital technology innovation on enterprise value and the mediating role of digital transformation. The result indicates that digital technology innovation extremely enhances enterprise value. The mechanism test shows that digital technology innovation can enhance enterprise value through digital transformation. Heterogeneity analysis shows that among private, high-tech and small and medium-sized enterprises, digital technology innovation can better enhance enterprise value.

**Keywords:** digital technology innovation, digital transformation, enterprise value

## 1. Introduction

The White Paper on the Global Digital Economy (2023) released by the China Academy of Information and Communications Technology (CAICT) estimates the added value of the digital economy of 51 countries in 2022, among them, the digital economy in the United States ranks first in the world, with a scale of \$17.2 trillion, China ranks second with a scale of \$7.5 trillion, the United Kingdom, Germany and the United States all account for more than 65% of GDP, and Saudi Arabia, Norway and Russia all have a digital economy growth rate of over 20%, ranking among the top three in the world. As the technical support of the digital economy, digital technology has become an essential component of economic development with its high spillover and greater relevance (Wang et al., 2021)<sup>[1]</sup>. As the main body of the market, enterprises are the main participants in economic activities, in particular that the current world has entered the digital economy era, and digital technology is becoming a momentous element affecting enterprise value and has received widespread attention from scholars. Therefore, it is of high importance to appraise the function of digital technology innovation in promoting enterprise value.

Currently, there has been a great quantity of research in academia on the digital economy and enterprise value, but most scholars' research mainly focuses on the relationship between digital transformation and enterprise value, and the repercussions of digital technology innovation has not been clearly analyzed. Existing research have shown that digital transformation mainly increases enterprise value by improving organizational capabilities (Ji et al., 2022)<sup>[2]</sup>,

production efficiency (Li et al., 2020)<sup>[3]</sup>, operational efficiency (Qi et al., 2022)<sup>[4]</sup>, and reducing enterprise costs (Lyytinen et al., 2016, Tiefenbeck, 2017)<sup>[5][6]</sup>. A small amount of literatures have begun to focus on the influence of the application of digital technologies in specific fields on enterprise value, such as information technology (Bharadwaj et al., 1999)<sup>[7]</sup>, digital twin (Nahavandi, 2019)<sup>[8]</sup>, big data applications (Bajari et al., 2019)<sup>[9]</sup>, and artificial intelligence (Wu et al., 2022)<sup>[10]</sup>. However, digital technology emphasizes the amalgamation of technologies, and the actual process of enterprise digital transformation is also diverse a combination of multiple digital technologies. Therefore, it is indispensable to comprehensively evaluate the implications of digital technology innovation on enterprise value.

Based on this, this paper matches the main classification number of patents of listed companies with the Statistical Classification of Digital Economy and Its Core Industries 2021 (hereinafter referred to as Digital Classification), constructs a data sample of digital invention patent applications, and then uses 1410 listed companies in China's A-share market from 2011 to 2022 as samples to test the impact of digital technology innovation on enterprise value. The result shows that digital technology innovation expressively enhances enterprise value, mechanism analysis shows that digital technology innovation enhances enterprise value by promoting enterprise digital transformation.

## **2. Theoretical analysis and research hypothesis**

### **2.1. Digital technology innovation and enterprise value**

Yoo et al. (2010) first pointed out that digital technology innovation is an innovation process in which digital components and physical components are combined to produce new products and services<sup>[11]</sup>. From a broader perspective, digital technology innovation is a process of creating and transforming digital technologies based on the original products, processes, and business models, emphasizing the innovation of production processes and organizational models (Shen et al., 2023)<sup>[12]</sup>. Digital technology is dynamic, extensible and programmable, can continue to iterate and change according to the internal situation of the enterprise (Ciriello et al., 2018)<sup>[13]</sup>, and digital technology innovation has the ability to break down the boundaries of organizations, departments and even products, blurring them (Nambisan et al., 2017)<sup>[14]</sup>. Therefore, digital technology innovation will have an impact on enterprise development and promote enterprise value.

First, digital technology innovation can enhance the development of new products, thereby promoting product updates, iteration and circulation (Tee et al., 2009)<sup>[15]</sup>, meeting the growing market demand for digital products, and thus enhancing enterprise value. Secondly, digital technology innovation has changed the business process of traditional products, from product development, production to procurement and sales, digital technology can promote enterprises to obtain various data and information of products more accurately, and break the traditional path dependence through data computing and processing (Xiao, 2020)<sup>[16]</sup>, which can not only improve the production efficiency of enterprises, but also better meet diversified and multi-level consumer needs. Digital technology can match and aggregate fragmented information, which can diminish the communication cost between the client and the supply side and enterprises (Brynjolfsson et al., 2011)<sup>[17]</sup>, it can optimize the business process of the

enterprise to achieve refined production, and can also improve capital operation efficiency and management efficiency, thereby enhancing the value of the enterprise (Zhang et al., 2023)<sup>[18]</sup>. Finally, digital technology innovation can overcome the limitations of space and society, enterprises can transmit information to internal and external sources more transparently, so that the transparency of business processes can be improved, effectively decreasing the risk of information asymmetry in enterprises and embellishing information transparency (Zhang et al., 2022; Zhang et al., 2022)<sup>[19][20]</sup>, thereby promoting enterprise value. From this, hypothesis 1 is presented:

Hypothesis 1. Digital technology innovation can considerably enhance enterprise value.

## **2.2. Digital technology innovation, digital transformation and enterprise value**

Digital technology is the technical support for digital transformation, and its innovation play a significant role in stimulating digital transformation (Yoo et al., 2012)<sup>[21]</sup>. It has been pointed out that digital transformation can boost value creation of enterprises (Vial, 2021, Yang et al., 2023)<sup>[22][23]</sup>. Therefore, this paper argues that digital technology innovation can enhance enterprise value by promoting digital transformation.

First of all, digital technology innovation is beneficial for establishment to establish digital technology systems and production processes, and enhances the value of enterprises by consolidating their technical foundation and improving their efficiency support. Enterprises can utilize the central underlying technologies of digital transformation to optimize resource allocation in the production process, improve input-output efficiency, and thus achieve the goal of enhancing enterprise value. Secondly, digital transformation has promoted a series of changes in the internal management model of enterprises, organizational processes and organizational culture have been significantly affected by digital technology (Verhoef et al., 2021)<sup>[24]</sup>, digital technology innovation is propitious to the establishment of digital product systems and business models, so as to enhance enterprise value by promoting the deep transformation of the core market business of the enterprise and stronger market business support. From this, hypothesis 2 is presented:

Hypothesis 2. Digital transformation mediates digital innovation and enterprise value.

## **3. Data, variables, and models**

### **3.1. Sample and data**

This article takes Chinese A-share listed companies from 2011 to 2022 as research samples, the samples of enterprises listed after 2011, listed in ST, \*ST and delisted during the research period are excluded, and the financial enterprises are deleted. For purpose of reducing the impression of outliers, this article applies a 1% tail reduction to variables, and finally takes 1410 listed companies as the research target. The data of digital technology innovation are mainly obtained from the China National Intellectual Property Administration (CNIPA) and China Statistical Yearbook, the data for digital transformation is mainly obtained by crawling keywords from enterprise annual reports, and the data of listed companies are from the CSMAR database.

## 3.2. Variable settings

### 3.2.1. Explained variables.

Enterprise value is used as the explained variable in this paper. Referring to existing research, because the Tobin Q value considers the current and future situation of the enterprise, reflects the stock price fluctuations of the external capital market, and represents the long-term feedback result of the market on the market value of the enterprise, it can more appropriately measure the enterprise value, so the Tobin Q value is used to measure the enterprise value. It is calculated as (total market capitalization + total liabilities) / total assets.

### 3.2.2. Explanatory variables.

In this paper, digital technology innovation is used as an explanatory variable. In general, many studies use the amount of patent applications to measure the ability of innovation of enterprises. In this paper, the quantity of digital patent applications of listed companies in each year is calculated by matching them with the Digital Classification according to the main classification number of the patents of listed companies. Add the amount of digital patent applications by 1 and then take the logarithm to indicate the level of digital technology innovation, which is expressed by Dti.

### 3.2.3. Mediation variables.

Taking digital transformation as the mediating variable, and consulting the practices of Wu et al. (2021)<sup>[10]</sup>, this article constructs 175 keywords reflecting "digital transformation" and based on this, divides the keywords into eight dimensions to statistically analyze the frequency of keyword appearances in the annual reports of 1410 listed companies. The frequency of keywords plus one is taken as the natural logarithm to represent digital transformation, which is represented by the variable Dg.

### 3.2.4. Control variables.

This article adds a series of control variables: enterprise size (Size); the shareholding ratio of the largest shareholder (Top1), which is measured by the proportion of the amount of shares held by the largest shareholder in the total number of shares of listed companies; the growth of the enterprise (Growth) is measured by the growth rate of the main business income of the listed company; management shareholding ratio (Marsh), measured by the proportion shares held by the management in the total share capital; and the proportion of independent directors (Indep).

## 3.3. Model construction

Model (1) is mainly used to verify the direct consequences of digital technology innovation on enterprise value.  $\alpha_{11}$  the most concerned parameters in this paper,  $\alpha_{11} > 0$  demonstrates that digital technology innovation enhances enterprise value, and  $\alpha_{11} < 0$  demonstrates that digital technology innovation has a negative impact on enterprise value.

$$Tobin Q_{it} = \alpha_{10} + \alpha_{11}Dti_{it} + \alpha_{12}Z_{it} + \theta_i + \varepsilon_{it} \quad (1)$$

Model (2) uses digital transformation as a mediating variable to analysis the effect path of

digital technology innovation on enterprise value.

$$Tobin\ Q_{it} = \alpha_{20} + \alpha_{21}Dti_{it} + \alpha_{22}Dg_{it} + \alpha_{23}Z_{it} + \theta_i + \varepsilon_{it} \quad (2)$$

Among them, *i* stands for the enterprise, *t* stands for time, Tobin Q serve as the enterprise value, *Dti* represents digital technology innovation, *Dg* represents digital transformation, and *Z* corresponds to an array of control variables, mainly including Size, Top1, Growth, Marsh and Indep,  $\theta$  is used to control the fixed effect of time, and  $\varepsilon$  represents the random perturbation term.

## 4. Empirical results

### 4.1. Descriptive statistical analysis

**Table 1** presents the descriptive statistical results of the main variables in this article.

**Table 1.** Descriptive statistics

	Mean	Sd	Min	Max
Tobin Q	1.864	1.127	0.816	7.149
Dti	0.595	1.143	0	5.298
Dg	9.390	0.436	8.386	10.54
Size	22.65	1.339	20.24	26.59
Top1	34.34	15.09	8.200	74.82
Growth	7.455	9.711	0.315	63.04
Marsh	0.0588	0.131	0	0.597
Indep	0.378	0.0726	0.250	0.600

From **Table 1**, it can be observed that the average value of digital technology innovation (*Dti*) is 0.595 and the maximum value is 5.298, which indicate that there are significant discrepancies in digital technology innovation investment among various enterprises. The weighted average value of Tobin Q was 1.864, the maximum is 7.149, and the minimum is only 0.816, so indicate that there was a large discrepancy in the profitability of enterprises. The average of digital transformation (*Dg*) is 9.390, the maximum is 10.54, and the minimum is 8.386, illustrate that most of enterprises are engaged in digital transformation, and the overall level is similar, and there is little difference among the sample enterprises.

### 4.2. Regression analysis

In this paper, a fixed-time effect model is selected for significance testing, and **Table 2** declares the benchmark regression results of the impression of digital technology innovation on enterprise value. In model 1-1, the regression coefficient of digital technology innovation level to enterprise value is 0.0329 without adding control variables, and it is optimistic at the significance level of 1%, clearly indicate that digital technology innovation substantially promotes the improvement of enterprise value. After adding control variables to the model 1-2, the regression coefficient values of digital technology innovation on enterprise value are improved, and all of them are positive values at the 1% significant level, and hypothesis 1 is verified.

**Table 2.** Benchmark regression results

	Model 1-1	Model 1-2
Dti	0.0329*** (0.00734)	0.110*** (0.00674)
Size		-0.388*** (0.00675)
Marsh		-0.265*** (0.0603)
Indep		0.673*** (0.105)
Growth		0.00161* (0.000844)
Top1		0.00199*** (0.000528)
Constant	1.844*** (0.00943)	10.27*** (0.152)
Year	Yes	Yes
Observations	16,534	16,534
R-squared	0.092	0.267

**Table 3** shows the mediating impact of digital transformation in digital technology innovation and enterprise value. It can be observed from **Table 3**, the regression coefficient of model 1 is 0.110, which demonstrates that digital technology innovation can tremendously strengthen the value of enterprises. Both regression coefficients in model 2 are significantly positive, among the digital transformation to enterprise value is 0.0429, and the digital technology innovation to enterprise value is 0.110, which means that the indirect and direct consequences of digital technology innovation on enterprise value are significant. The conclusions indicate that the digital transformation of enterprises engages in a partial intermediary part in digital technological innovation and enterprise value, and hypothesis 2 is verified.

**Table 3.** Results of mediation effect test

	Model 1	Model 2
Dg		0.0429** (0.0194)
Dti	0.110*** (0.00674)	0.110*** (0.00674)
Control variables	Yes	Yes
Year	Yes	Yes
Observations	16,534	16,534
R-squared	0.267	0.267

#### 4.3. Stability test

So as to make certain the accuracy of the research results, an array of robustness tests was conducted in this article. Firstly, since the value of the enterprise may have a time series correlation, it will under the influence of the previous years, based on this, the value of the enterprise is retested after one period of regression. Secondly, for some enterprises, the amount of digital invention patent applications during the study period was 0, considering the impact on the faultlessness of the regression results, they were deleted. **Table 4** presents the results of the robustness test, which is same as benchmark regression results.

**Table 4.** Robustness test

	Lag enterprise value		Remove extreme values	
	Model 1	Model 2	Model 1	Model 2
Dg		0.0915*** (0.0213)		0.0478* (0.0247)
Dti	0.108*** (0.00714)	0.108*** (0.00713)	0.0919*** (0.00764)	0.0918*** (0.00764)
Control variables	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	14,794	14,794	9,700	9,700
R-squared	0.246	0.247	0.237	0.237

#### 4.4. Heterogeneity test

There may also be obvious differences in the impression of digital technology innovation on the value of enterprises with different property rights. From the perspective of business objectives, private enterprises simply pursue profit maximization as their goal, while state-owned enterprises need to consider multiple economic, social, and political goals. From the perspective of the business environment, state-owned enterprises have the advantage of soft budget constraints and are more likely to obtain policy support, while private enterprises have more difficulty in obtaining bank loans and policy preferences (Allen et al., 2005). As a result, private enterprises are under greater pressure than state-owned enterprises to increase their corporate value through digital technology innovation. On this basis, this dissertation uses the enterprise property rights data of the CSMAR database to separate the listed company into state-owned enterprises and private enterprises for heterogeneity testing. The test outcomes are presented in **Table 5**, which indicated that the estimation coefficient of digital technology innovation of private enterprises on enterprise value is larger. This demonstrates that digital technology innovation has a more crucial position in enhancing the value of private enterprises.

**Table 5.** Property heterogeneity test

	Private enterprises		State-owned enterprises	
	Model 1	Model 2	Model 1	Model 2
Dg		0.0157 (0.0309)		0.0290 (0.0246)
Dti	0.123*** (0.0118)	0.123*** (0.0118)	0.0993*** (0.00784)	0.0994*** (0.00784)
Control variables	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	7,489	7,489	9,045	9,045
R-squared	0.260	0.260	0.257	0.257

To explore the dissimilarity in the influence of digital technology innovation on enterprise value among different industries. Consult the research of Ji et al. (2022)<sup>[25]</sup>, according to the GB/T4754 industry categorization quality of the National Bureau of Statistics of China, all research samples were divided into high-tech companies and non-high-tech companies. The research results of the impact of digital technology innovation on enterprise value in different industries are shown in **Table 6**, the results show that compared to non-high-tech companies,

digital technology innovation in high-tech companies has a significantly greater impact on enterprise value.

**Table 6.** Industry heterogeneity test

	Non-high-tech industries		High-tech industry	
	Model 1	Model 2	Model 1	Model 2
Dg		0.00470 (0.0219)		-0.0718* (0.0367)
Dti	0.0513*** (0.0109)	0.0514*** (0.0110)	0.0720*** (0.0106)	0.0710*** (0.0106)
Control variables	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	10,484	10,484	6,050	6,050
R-squared	0.267	0.267	0.240	0.240

There may be some differences in the value enhancement of enterprises of different sizes due to digital technology innovation. Compared with large and medium-sized enterprises (MLEs), small and medium-sized enterprises (SMEs) face troubles such as large financing restrictions and weak digital infrastructure, however, once SMEs carry out digital technology innovation, they will expand financing channels, ease financing constraints, and increase learning speed. Therefore, compared with large and medium-sized enterprises, SMEs may significantly increase their enterprise value through digital technology innovation. The test results of enterprise size heterogeneity are shown in **Table 7**, and illustrates that compared with MLEs, the effect coefficient of digital technology innovation on the value of SMEs is greater, indicating that the impact effect is stronger.

**Table 7.** enterprise size heterogeneity test

	small and medium-sized		large and medium-sized	
	Model 1	Model 2	Model 1	Model 2
Dg		0.0818** (0.0415)		0.00888 (0.0226)
Dti	0.160*** (0.0125)	0.158*** (0.0125)	0.0860*** (0.00802)	0.0861*** (0.00802)
Control variables	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	4,918	4,918	11,616	11,616
R-squared	0.265	0.265	0.266	0.266

## 5. Conclusions

According to the matching of the main classification number of the patents of listed companies with the Digital Classification, the invention patents with the characteristics of digital technology innovation are identified, and the relevant indicators of digital technology innovation from 2011 to 2022 are constructed, and then the paper investigated the effect of digital technology innovation on enterprise value and its transmission mechanism. Research



points out that: (1) Digital technology innovation can meaningfully stimulate the improvement of enterprise value. (2) Digital transformation has played a part of the mediating impact between digital technology innovation and enterprise value. To a certain extent, digital technology innovation enhances enterprise value by promoting the path of enterprise digital transformation. (3) Heterogeneity analysis manifests that digital technology innovation has an excessive consequence on the value of private enterprises, high-tech industries and SMEs.

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