

The Influence of Digitalization Degree on Enterprise Performance in the Era of Big Data

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Abstract: At present, emerging science and technology such as big data and cloud computing have a huge impact on the business mode of enterprises, making the model and business logic of the whole economic market have changed unprecedentedly, and therefore the development environment of enterprises is also changing. In the process of integration with the real economy, the digital economy has shown great ability to transform and promote traditional industries, forming new driving forces for economic development. In order to seize the "new commanding heights" and development opportunities in the era of digital economy, many countries, including China, have put forward from the national strategic level to vigorously promote the digitalization of the real firm. In this context, the level of digitization of firm and the various institutional management within enterprises have very important significance to the governance mode, management mode, operation and decision-making mechanism of enterprises. Based on the current situation of enterprise digital transformation, this paper selects A-share listed companies in manufacturing industry as samples, adopts fixed effect model to discuss the influence of enterprise digitalization degree on enterprise performance, and provides reference value for enterprise digital transformation. The results show that the degree of digitalization has a positive impact on enterprise performance; R&D investment and human capital play an intermediary role between enterprise digital transformation and enterprise performance.

Keywords: Digitalization Degree, Enterprise Performance, R&D Investment, Human Capital

1. Introduction

The development and reform of the digital economy has brought a lot of impact on the real economy, changing the economic model and business logic. Meanwhile, it has led all kinds of real economy to take a big step towards the digital economy, from the Internet industry and financial industry, which have the advantage of data resources at the beginning, to the traditional industries such as manufacturing and retail industry [1]. From the Internet industry and the financial industry that initially entered the field with data resource advantages, it has turned to manufacturing, retail and other traditional industries. industry sector. In this environment, digital transformation of enterprises has become a consensus. As we all know, China has attached great importance to and encouraged the reform and development of the real economy in recent years. The government has formulated various

strategies aimed at promoting the development of the real economy and driving the development of other industries. At present, my country has not yet become a powerful manufacturing country in the world. Therefore, it is necessary to use technological innovation to drive industrial competitiveness [2], break through the pattern of low-end manufacturing, and enable my country to continue to promote the digitalization of manufacturing. At present, the traditional industry manufacturing industry needs to carry out digital research in the manufacturing industry to promote the widespread use of related science and technology. Therefore, in the context of the era of big data, it is necessary to study the impact of the degree of digitalization of the manufacturing industry on enterprise performance, digital integration of the manufacturing industry and technological innovation. etc. are of great significance.

2. Literature Review and Research Hypothesis

2.1. Domestic Digital Development

In the era of big data, digital transformation involves not only the updating of traditional businesses and technologies, but also the deep integration of the internal organizational structure of the enterprise and various businesses, so as to realize the true digitization of the core departments and business forms of the enterprise. On the level to achieve the healthy development of enterprises. The research direction of digitalization in academia includes the business performance of digital transformation of small and medium-sized enterprises, and the study of the logical path of digital transformation. Xue Jingli defines digitization, saying that digitization is "change, integration, and remodeling". Transformation is the use of digital information to improve the technical level; integration is to realize the comprehensive integration of the real and virtual levels, to realize the integration of information technology and enterprise business; remodeling is to realize the digitalization of the traditional business format reshaping [3]. Scholars such as Wu Xi (2017) believe that this new economic trend "new digital technology and traditional enterprises" has the characteristics of transformation from old to new and innovation-driven [4].

2.2. The Relationship Between the Degree of Digitalization and Enterprise Performance

In the context of the rapid development of big data, whether it is finance, Internet enterprises or traditional enterprises, in order to continuously improve enterprise performance and create new advantages in core competition, they are gradually undergoing digital transformation. Most scholars believe that enterprise digitalization can promote the growth of business performance and accelerate the transformation and upgrading of enterprises. Scholars such as Chen Jian believe that digitalization can significantly improve the operational efficiency of enterprises, among which factors such as R&D, supply chain management, and pricing of enterprises are significantly affected [5]. Many foreign scholars generally pay attention to the importance of the degree of digitalization of enterprises and the relationship between the degree of digitalization and enterprise performance. Scholars such as Zhu believe that the factors affecting the degree of digitalization of enterprises include digital technology advantages, enterprise scale, digital competition pressure, and partnerships [6]. Büchi studied the degree of digital technology from the impact mechanism of enterprise production, sales, and operation [7]. Scholars such as Zhang Sanfeng believe that digital transformation will trigger technological changes [8], which will lead to changes in management, organization, culture, concepts, etc. These changes in turn promote technological changes and ultimately lead to the improvement of enterprise performance. Qiu Haoran and Xu Hui believe that the impact of digitalization on enterprise performance is not always positive, because the

influencing factors of digital transformation are not single, so it will affect enterprise performance from many aspects [9]. Therefore, when studying the relationship between the two, the causes and results of various factors are uncertain. In the research process, we need to consider various factors such as technology, organization, environment, policy, etc., and clarify the mechanism of action in order to effectively study The relationship between the degree of enterprise digitization and enterprise performance.

According to the previous researches of scholars, this paper believes that the similarities and differences in the research may be caused by the different selection of time or measurement indicators. Therefore, this paper puts forward the following assumptions on this basis:

H1: The degree of digitalization of an enterprise has a positive impact on enterprise performance.

The relationship shows that the ratio of digital capital investment and digital personnel has a significant positive impact on enterprise performance, that is, the higher the degree of enterprise digitalization, the operating profitability of the enterprise shows an upward trend, which may be due to the increase in digital investment of enterprises. The market shows an increase in firm value and therefore has a positive impact on performance.

H2: R&D investment plays a mediating role between enterprise digital transformation and enterprise performance.

Although the results of research and development are often uncertain and the results of research and development investments are rarely immediate, research and development investments have been shown to generate future growth opportunities, potentially increasing profits and giving companies a competitive advantage [10]. R&D investment reflects the importance an enterprise attaches to knowledge and innovation, and is an important way to affect the business performance of the enterprise. Enterprise digitization can increase the innovation strength of the enterprise through R&D investment, thereby enhancing the competitiveness of products, thereby improving the business performance of the enterprise.

H3: Human capital levels play a mediating role between digital transformation and corporate performance.

With higher human capital, they have better performance in the application of new technologies, the discovery of new business opportunities and other opportunities identification [11]. The level of human capital reflects the quality of the employees of the enterprise to a certain extent, and has an important impact on the perception, acquisition and reconstruction capabilities of the enterprise. Digitalization requires higher-quality human capital to learn new digital technologies, thereby improving the operating efficiency of the enterprise, and ultimately Improve business performance.

3. Study Design

3.1. Sample Selection and Data Sources

This paper takes manufacturing A-share listed companies as the research sample, the solved variable tobing comes from

the Guotai'an database (CSMAR); the core explanatory variables come from the annual reports of listed companies in the www.cninfo.com.cn; the control variables come from the Guotai'an database (CSMAR) and choice financial terminal; the sample interval is 2016-2020.

In this paper, the obtained excel data is imported into stata15 software for data processing. In the process of data processing, the missing values of variables are deleted first. In order to exclude the influence of outliers, the variables with larger standard errors were tailed at the 1% and 99% positions of the distribution using the winsor2 command. After data processing, 1,738 listed companies were finally obtained, with a total of 8,227 samples.

3.2. Variable Design

3.2.1. Explained Variable

TobinQ value summarizes all the information about the manufacturer's investment decision, which can comprehensively reflect the company's performance, growth, company investment value and other information, and the comprehensive reflection of these information is closely related to the company's market value. TobinQ value is widely used as the most authoritative index to measure the market value of enterprises [12]; so TobinQ value is selected as a proxy variable to measure the market value of enterprises.

3.2.2. Core Explanatory Variables

Proportion of digital intangible assets (Digitaln). Based on the details of the year-end intangible assets disclosed in the notes to the financial report of the listed company, the measurement indicators of the intangible assets related to the digital technology of the enterprise are obtained. On this basis, the application level of enterprise digital technology is measured by the proportion of digital technology-related intangible assets in all intangible assets [13].

3.2.3. Mediating Variable

R&D investment (RD), the ratio of R&D expenditure to operating income (RD), this indicator reflects the importance of knowledge and innovation of enterprises, and is an important way to affect the business performance of enterprises. It is measured by the ratio of R&D expenditure to total assets.

Human capital level (edu). This indicator reflects the quality of enterprise employees to a certain extent, and has an important impact on enterprise perception, acquisition and reconstruction capabilities. It is measured by the proportion of employees with a bachelor's degree or above in the total employees.

3.2.4. Control Variable

Asset-liability ratio (lev), measured by the ratio of total liabilities at the end of the period to total assets at the end of the period.

The ability to obtain cash (liq), which uses the net cash flow to measure the ability to obtain cash of the company's assets;

Two-in-one (CEO_duality), whether the chairman and the general manager of the listed company are combined at the end of the year, if yes, it is equal to 1, otherwise it is 0;

The management shareholding ratio (Mshare) is calculated by dividing the number of shares held by senior executives of the listed company by the total number of shares at the end of the year;

Growth capacity (growthy), using the growth rate of operating income to measure the growth capacity of the enterprise.

The age of the company (listage) is measured by the year of the listed company minus the year of listing, and the natural logarithm is taken to mitigate heteroscedasticity.

The variable design of this paper is shown in Table 1:

Table 1. Variable Design.

variable type	variable name	Variable connotation
Explained variable	tobinq	Year-end total market value/year-end total assets
core explanatory variables	Digitaln	Based on the detailed items of intangible assets at the end of the year, the proportion of the intangible assets related to the digital technology of the enterprise to the total assets is obtained.
	Digital	The number of digital transformation-related keywords (+1) in the corporate annual report is taken as the natural logarithm
mediating variable	RD	R&D expenditure as a percentage of operating income and standardized
	Edu	The proportion of undergraduates or above, and standardized processing
control variable	lev	Asset-liability ratio = total liabilities at the end of the period / total assets at the end of the period
	liq	Net cash flow from operating activities
	CEO_duality	At the end of the year, whether the two positions of the chairman and the general manager are combined, if yes, it is equal to 1, otherwise it is 0
	Mshare	Calculated by dividing the number of shares held by senior executives by the total number of shares at the end of the year
	growthy	Year-on-year growth rate of operating income
	listage	Measured by subtracting the year of listing from the current year

3.3. Model Construction

(1) According to the assumptions proposed in this paper, construct the following baseline effect model:

$$TBQ_{i,t} = \alpha_0 + \alpha_1 X_{i,t} + \alpha_2 Controls_{i,t} + v_i + v_t + \varepsilon_i$$

(2) Referring to the practice of the existing literature, set the following measurement model of the mediation effect [14]:

$$y_{i,t} = \alpha_0 + \beta_1 X_{i,t} + \beta_2 \text{Controls}_{i,t} + v_i + v_t + \varepsilon_i \quad (1)$$

$$M_{i,t} = \beta_0 + \beta_1 X_{i,t} + \beta_2 \text{Controls}_{i,t} + \gamma_{i,d} + \gamma_t + \varepsilon_{i,t} \quad (2)$$

$$y_{i,t} = \beta_0 + \alpha_0 X_{i,t} + \beta_1 M_{i,t} + \beta_2 \text{Controls}_{i,t} + v_{i,d} + v_t + \varepsilon_{i,t} \quad (3)$$

Among them, the explained variable of the econometric model is $y_{i,t}$ the proxy variable that reflects business performance; the core explanatory variable $X_{i,t}$ is the proxy variable that reflects the level of digitization; $\text{Controls}_{i,t}$ it is the control variable that reflects the characteristics of the enterprise, including the individual characteristics of the enterprise; $M_{i,t}$ it is the intermediary variable of this paper, reflecting the and v_t are the industry fixed effect and time fixed effect, respectively $\varepsilon_{i,t}$, and are v_i random interference terms.

4. Analysis of Empirical Results

4.1. Variable Descriptive Statistics

The descriptive statistics of variables are shown in Table 2. The Tobin q value that reflects the performance of the enterprise has a large difference between the minimum value and the maximum value, but the overall standard deviation difference is not large, indicating that the deviation of individual values does not affect the overall sample distribution. degree, so it will not affect the estimated results. The standard deviation of the intermediary variable human capital edu is 16.344, which is much larger than other variables, indicating that there is a large gap in human capital among different enterprises. The differences in the standard deviations of the other variables

are relatively small.

Table 2. Variable Descriptive Statistics.

	N	Mean	St.Dev	min	max
tobinq	8227	2.029	2.143	1.774	92.250
Digital	6686	1.901	1.161	-5.145	5.656
Digitaln	7521	0.103	0.157	-0.128	1.001
edu	8491	20.744	16.344	0	100
RD	8252	0.046	0.047	0	1.259
Lev	8227	0.402	0.188	0.008	1.748
liq	8227	0.056	0.069	-0.657	0.661
CEO duality	8227	0.287	0.453	0	1
IDS	8227	0.375	0.056	0	0.8
listage	8227	2.197	0.863	0	3.434
mshare	8227	0.142	0.206	0	3.198
growthy	8227	0.254	4.937	-0.95	429.036

4.2. Correlation Analysis and Multicollinearity Analysis

In order to test the scientificity and rationality of variable selection, the correlation between explained variables, core explanatory variables and control variables is tested, and the results are shown in Table 3. The core key explanatory variable Digital is positively correlated with tobinq and is not significant, which may be due to ignoring the influence of other variables, leading to biased results; Digitaln and tobinq are positively correlated and significant, which is consistent with expectations. In addition, enterprise size (size) and management shareholding ratio (Mshare) are significantly negatively correlated, but both are less than 0.7, indicating that there is no serious multicollinearity. There was a significant positive correlation between other variables and tobinq. The results of correlation analysis show that the variables selected in this paper are appropriate.

Table 3. Correlation analysis.

Variables	tobinq	Digital2	Digitaln2	Lev	liq	CEO_duality	IDS	listage	mshare	growthy
tobinq	1.000									
Digital2	0.011	1.000								
Digitaln2	0.064***	0.348***	1.000							
Lev	-0.093***	-0.002	-0.006	1.000						
liq	0.037***	-0.046***	-0.019*	-0.169***	1.000					
CEO_duality	0.046***	0.059***	0.020*	-0.116***	0.017	1.000				
IDS	0.035***	0.037***	0.027**	-0.001	0.019*	0.092***	1.000			
listage	0.030***	0.019	-0.038***	0.297***	-0.064***	-0.256***	-0.023**	1.000		
mshare	-0.024**	0.020	0.034***	-0.242***	0.050***	0.244***	0.047***	-0.571***	1.000	
growthy	-0.008	0.009	-0.006	0.028***	-0.022**	-0.001	-0.004	0.017	-0.009	1.000

Table 4. Multicollinearity Analysis.

	VIF	1/VIF
listage	1.570	0.635
mshare	1.490	0.669
edu	1.370	0.732
RD	1.270	0.788
Lev	1.160	0.860
Digitaln2	1.150	0.872
CEO_duality	1.100	0.913
liq	1.040	0.963
growthy	1.000	0.998

To further test whether there is multicollinearity between

the variables, this paper uses the variance inflation factor analysis method to determine whether there is multicollinearity among the explanatory variables. The analysis results are shown in Table 4. It can be seen from the analysis results that the VIF values of each explanatory variable are all within 10, and the tolerances are all greater than 0.1, indicating that there is no multicollinearity among the explanatory variables.

4.3. Benchmark Regression Analysis

As shown in Table 5: (1) No control variables are added, (2) fixed effects of control variables, time and industry are added,

(3) fixed effects of control variables, time, industry and individual are added. Digitaln is significantly positive, indicating that digitization can significantly promote enterprise performance, and test Hypothesis 1.

Table 5. Benchmark regression results.

	(1)	(2)	(3)
Digitaln	0.6377 *** (5.461)	0.4320 *** (3.224)	0.4320 ** (2.250)
Lev		-1.3426 *** (-10.736)	-1.3426 *** (-6.572)
liq		2.0046 *** (4.817)	2.0046 *** (3.831)
CEO_duality		0.0802 ** (2.203)	0.0802 (1.595)
IDS		0.8644 *** (2.855)	0.8644 ** (1.979)
listage		0.1176 *** (5.587)	0.1176 *** (3.559)
mshare		-0.2174 *** (-2.888)	-0.2174 * (-1.958)
growthy		0.0000 (0.053)	0.0000 (0.050)
years	No	Yes _	Yes _
industry	No	Yes _	Yes _
individual	No	No	Yes _
_cons	1.9389 *** (88.416)	1.9862 *** (7.211)	1.9862 *** (4.313)
N	7315	7315	7315
r2_a	0.0039	0.3109	0.3109

Note: ***, **, and * represent significant levels at 1%, 5%, and 10%, respectively, the same below.

4.4. Robust Test

Replace the explained variable and the core explained variable, Using the research method of Wu Fei et al., this paper then uses Python's urllib, pdfplumber and jieba to crawl the annual reports of listed companies in Jichao, extract the frequency of the above keywords in the annual reports, and add the total word frequency to get the enterprise Digital transformation index (Digital). And the Digital transformation index (Digital) is used as the substitution variable of the digital assets ratio (Digitaln). Since the index has a typical right-bias feature, the total word frequency (+1) is further taken as a natural number [15]. The core explanatory variable was further replaced by digitization index Digital, and the robustness test was conducted. As shown in Table 6, after controlling the control variables, digitization positively promoted the business performance of the enterprise.

Table 6. Robust test.

	(1)	(2)	(3)
Digital	0.0149 (1.175)	0.0550 *** (4.353)	0.0550 ** (2.395)
Lev		-0.3922 *** (-5.016)	-0.3922 *** (-3.501)
liq		4.3444 ***	4.3444 ***

	(1)	(2)	(3)
CEO_duality		(10.677) 0.0140	(5.727) 0.0140
IDS		(0.464) 1.1520 **	(0.393) 1.1520
listage		(2.277) -0.0404 *	(1.192) -0.0404
mshare		(-1.835) 0.1070	(-1.233) 0.1070
growthy		(0.885) 0.0023	(0.813) 0.0023
year	No	(1.232) Yes	(1.225) Yes
industry	No	Yes	Yes
individual	No	No	Yes
_cons	0.4302 *** (15.198)	-0.5675 ** (-1.990)	-0.5675 (-1.094)
N	6686	6476	6476
r2_a	0.0001	0.1225	0.1225

4.5. Analysis of Mediation Effect

Mediation effect analysis are shown in Table 7. It can be seen from (1) that the coefficient of digital Digitaln is significantly positive, indicating that the increase will promote the R&D investment of enterprises. Model (2) The coefficients of RD and digitization Digitaln are significantly positive, indicating that the mediating effect of digitization through R&D investment is established. Verify Hypothesis 2. Similarly, according to the results of (3) and (4), the mediating effect of human capital investment can also be established, and hypothesis 3 is verified.

Table 7. Mediating effect analysis.

	(1) RD	(2) tobinq	(3) edu	(4) tobinq
Digitaln	0.0126 ** (2,356)	0.4201 ** (2,045)	13.5595 *** (4,220)	0.3937 * (1,890)
RD		5.0455 *** (2,592)		
edu				0.0028 ** (2,312)
Lev	-0.0292 *** (-7,420)	-1.2556 *** (-7,781)	-0.3341 (-0.194)	-1.3417 *** (-6,575)
liq	-0.0228 *** (-2.829)	2.2915 *** (4.643)	-2.8393 (-0.818)	2.0126 *** (3.847)
CEO_duality	0.0008 (0.838)	0.0509 (1.061)	-0.6487 (-1.105)	0.0820 (1.637)
IDS	0.0127 (1.480)	0.5673 (1.438)	12.7677 ** (2.420)	0.8283 * (1.887)
listage	-0.0013 ** (-2.017)	0.1031 *** (3.079)	2.2521 *** (5.484)	0.1113 *** (3.394)
mshare	0.0056 ** (2.149)	-0.2480 ** (-2.183)	0.8215 (0.507)	-0.2197 ** (-1.987)
growthy	0.0001 (1.322)	-0.0004 (-0.371)	0.0711 *** (8.260)	-0.0002 (-0.204)
years	Yes	Yes	Yes	Yes
industry	Yes	Yes	Yes	Yes
individual	Yes	Yes	Yes	Yes
_cons	0.0093 (1.512)	1.7311 *** (6.832)	-9.3638 *** (-2.833)	2.0126 *** (4.316)
N	7166	7166	7315	7315
r2_a	0.3064	0.3464	0.3899	0.3114

5. Conclusions and Recommendations

This paper draws the following conclusions through empirical research: First, the relationship between the level of digitalization of an enterprise and its performance has a significant positive impact. Both the investment of digital capital and digital personnel can deepen the digitalization degree of the enterprise, so that the digital transformation of the enterprise can start from All aspects of the organization undergo comprehensive changes, so digital transformation can bring better practical benefits to the enterprise. At the same time, the R&D investment and human capital of enterprises have played a mediating role in the relationship between the level of digitalization and enterprise performance to a certain extent, which shows that the R&D investment of enterprises enables enterprises to have better innovation capabilities and bring more benefits to enterprises. The profit of the company has brought into play the greater value of enterprise digitalization.

According to the research results of this paper, the following suggestions are put forward: First, we should continue to strengthen the digital transformation and transformation of enterprises, increase investment in digitalization, and achieve long-term growth of enterprise performance. In recent years, my country has been at the forefront of the digital economy in the international market, but the digital investment of various enterprises is still far behind. Only by increasing the investment in digitalization can we gain a competitive advantage in the international market. The second is to continue to increase the R&D investment and human capital of enterprises to increase innovation vitality. In the era of big data, the development of the digital economy has higher requirements on the innovation ability of enterprises. Enterprises should adjust the proportion of resource investment, fully tap enterprise resources, enhance the innovation ability of enterprises, and realize long-term development of enterprises.

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