Research on the Impact of e-commerce Development on Enterprise Digital Transformation: Based on the Intermediary Effect of R&D Investment

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Abstract. The integration of internet information technology and e-commerce has led to the digitalization of the production and operation mode of enterprises. In order to explore the impact of e-commerce development on the digital transformation of manufacturing enterprises, this paper takes listed companies of China's A-share manufacturing enterprises from 2013 to 2020 as research samples to empirically test it. The results show that the development level of e-commerce has significantly promoted the digital transformation of enterprises, and in areas with high development level of e-commerce, enterprises are more inclined to digital transformation. The further research shows that the development of e-commerce promotes the digital transformation of enterprises by increasing the R&D investment of enterprises.

Keywords: e-commerce development · R&D investment · Digital transformation

1 Introduction

With the improvement of Internet information technology, e-commerce has developed rapidly, China's economic development mode is also changing, and digital transformation has become an important factor in high-quality economic development. According to the existing literature, the research on enterprise digital transformation mainly considers the impact of enterprise digital transformation, and few studies analyze the external driving factors of enterprise digital transformation. The research on e-commerce promoting industrial upgrading can be divided into theoretical analysis and empirical analysis. The empirical analysis is mainly the research on e-commerce improving enterprise performance, while the research on e-commerce development promoting industrial transformation and upgrading is mainly based on theoretical analysis. There are still deficiencies in the exploration of the microeconomic consequences and impact mechanism of e-commerce development. For the manufacturing industry, they can use e-commerce to

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achieve data-driven optimization of service and production factor configuration, reduce production costs, and ultimately achieve enterprise transformation and upgrading [1]. Based on this, the paper intends to integrate e-commerce development and enterprise digital transformation into a research framework, and empirically test its internal mechanism and implementation path. The possible contributions of this paper are as follows: First, explore the external driving factors of enterprise digital transformation, and enrich the research perspective of existing literature; Secondly, empirical analysis of the impact of e-commerce on the digital transformation of enterprises will enrich the research methods of existing literature.

2 Literature Review and Hypothesis Presentation

2.1 Direct Impact of e-commerce Development on Enterprise Digital Transformation

Information technology has broken the restrictions of traditional commercial trade, enabling both suppliers and consumers to take advantage of the information of products. The integration of information technology and e-commerce promotes the exchange between industries and the formation of industrial chains, and helps enterprises to make their production and business processes more informative and scientific, and digitize product design, product manufacturing, production management and business processes to achieve intelligence [2, 14, 17]. And scholars pointed out that e-commerce has a great role and influence on the flat organizational structure [3], digital production and design of manufacturing enterprises, and the deep integration of manufacturing and internet will form an intelligent manufacturing ecosystem [4]. The emergence of e-commerce has changed the organizational structure, production management, technical level and other aspects of the industry [5]. It provides a series of high-quality technical tools to help enterprises carry out technical analysis, make digital projects accurately match with the available resources of enterprises, and enhance the ability of digital transformation of enterprises. And research found that there are regional differences in the level of digitalization of enterprises [6, 13, 18], the economic development of different regions is uneven, and the geographical distribution of the digital economy is related to economic development, which will affect the digital transformation of manufacturing enterprises. In areas with a high level of e-commerce development, government departments have issued more policies and related measures, including digital technology platforms and collaborative systems, which provide a certain impetus for the digital transformation of enterprises. Based on this, this paper puts forward the following assumptions:

H1: The development level of e-commerce will promote the digital transformation of enterprises.

2.2 Indirect Impact of e-commerce Development on Enterprise Digital Transformation

The development of e-commerce provides information, data and other support for manufacturing enterprises, and computer information encryption technology and firewall

technology can protect e-commerce exchange information and classify its data, which effectively reduces the processing and acquisition costs of decision-making information and increases the sensitivity of management to data information, inhibits short-sighted behavior, tends to invest more funds in long-term research and development activities. Computer network security technology has purified the e-commerce environment, which not only enables enterprises to obtain more valuable resources, but also improves their risk tolerance and willingness to carry out research and development activities, the research found that e-commerce development can promote R&D investment [7, 15], which is the most important driving force for digital transformation [8, 16]. With the increase of enterprise R&D investment, enterprises have significantly improved their sensitivity to cutting-edge technology, dug out internal and external favorable information, and improved their information integration ability. These have greatly improved the technological innovation strength of enterprises, laid abundant basic hardware conditions for enterprise digital transformation, and provided basic guarantee and technical support for digital transformation, thus promoting enterprise digital transformation [9, 12]. Based on this, this paper proposes the following research assumptions:

H2: The development of e-commerce promotes the digital transformation of enterprises by increasing the R&D investment.

3 Methods

3.1 Sample Selection and Data Collection

This paper selects listed companies of A-share manufacturing enterprises from 2013 to 2020 as the research sample, and the original data are from the CSMAR database. This paper deals with the above data as follows: First, excluding ST enterprises, such companies have abnormal data and are not comparable with ordinary enterprises; Second, eliminate enterprises with serious lack of relevant data; Third, in order to reduce the interference of outliers, the continuous variables at the enterprise level are subject to bilateral 1% tail reduction. Finally, a total of 14163 observations were obtained.

3.2 Variable Definition and Measurement

Dependent variable: Digital transformation of enterprises (Digital). Using the method of Wang Hongming [10]. The key word frequency of digital transformation is extracted from the annual report of enterprises, and finally the total word frequency is summed up and logarithmized.

Independent variable: digital industrialization (sale). Measured by the level of e-commerce development, using the provincial e-commerce sales volume as the proxy variable [11], and the logarithmic processing is carried out.

Control variables. This paper selects the following control variables: enterprise size(Size), measured by the logarithm of the total assets of the enterprise; Age of the enterprise(Age), measured by the natural logarithm of the difference between the sample year and the year of establishment of the enterprise; Return on total assets (Roa), using the proportion of net profit to total assets; Return on net assets (Roe), using the proportion of net profit to net assets; Ownership concentration(Stock) is measured by the shareholding ratio of the largest shareholder.

3.3 Hypothetical Model

Through theoretical analysis, this paper assumes that the development level of e-commerce affects the digital transformation of enterprises by influencing the R&D investment of enterprises, and the R&D investment of enterprises mediates the impact of the development level of e-commerce on the digital transformation of enterprises. This paper sets the following model:

$$\begin{aligned} \mathrm{Lndigital}_{i,t} =& \beta 0 + \beta 1 \mathrm{Lnsale}_{i,t} + \beta 2 \mathrm{Size}_{i,t} + \beta 3 \mathrm{Age}_{i,t} + \beta 4 \mathrm{Lev}_{i,t} \\ &+ \beta 5 \mathrm{Roa}_{i,t} + \beta 6 \mathrm{Roe}_{i,t} + \beta 7 \mathrm{Stock}_{i,t} + \sum \mathrm{Year} + \sum \mathrm{Industry} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

$$\begin{aligned} \mathrm{RD}_{i,t} =& \alpha 0 + \alpha 1 \mathrm{Lnsale}_{i,t} + \alpha 2 \mathrm{Size}_{i,t} + \alpha 3 \mathrm{Age}_{i,t} + \alpha 4 \mathrm{Lev}_{i,t} \\ &+ \alpha 5 \mathrm{Roa}_{i,t} + \alpha 6 \mathrm{Roe}_{i,t} + \alpha 7 \mathrm{Stock}_{i,t} + \sum \mathrm{Year} + \sum \mathrm{Industry} + \varepsilon_{i,t} \end{aligned} \tag{2}$$

$$\begin{aligned} \mathrm{Lndigital}_{i,t} =& \beta' 0 + \beta' 1 \mathrm{Lnsalei,t} + \beta' 2 \mathrm{RDi,t} + \beta' 3 \mathrm{Size}_{i,t} + \beta' 4 \mathrm{Age}_{i,t} \\ &+ \beta' 5 \mathrm{Lev}_{i,t} + \beta' 6 \mathrm{Roa}_{i,t} + \beta' 7 \mathrm{Roe}_{i,t} + \beta' 8 \mathrm{Stock}_{i,t} + \sum \mathrm{Year} + \sum \mathrm{Industry} + \varepsilon_{i,t} \end{aligned} \tag{3}$$

4 Results

Table 1 is Descriptive statistics. The average of Lndigital is 1.241, and the minimum and maximum is 0 and 4.635 respectively, which indicates that there are large differences in the degree of digital transformation among manufacturing enterprises. The average of Lnsale is 8.706, and minimum is 5.630. It indicates that there are significant differences in e-commerce development levels between regions. R&D investment with an average of 4.661, indicates that the overall R&D investment of enterprises is low. Through VIF test, the maximum value of VIF of each variable is 3.680, indicating that there is no multicollinearity problem among the variables.

Table 2 shows the correlation between various variables. The level of e-commerce development (Lnsale) is positively correlated with the degree of enterprise digital transformation (Lndigital), and the level of e-commerce development (Lnsale) is positively correlated with enterprise R&D investment (RD), indicating that the level of e-commerce development has a positive role in promoting enterprise R&D investment and digital transformation to a certain extent.

Table 3 is Regression analysis. From model (1), the regression coefficient between e-commerce development level (Lnsale) and enterprise digital transformation (Lndigital) is 0.069, indicating that e-commerce development level is positively promoting enterprise digital transformation, and hypothesis 1 is verified. Model (2) shows the coefficient between e-commerce development level and R&D investment is 0.193, indicating that e-commerce development level is positively promoting R&D investment; Model (3) shows that the regression coefficient between R&D investment (RD) and digital transformation is 0.034; Explain that R&D investment is promoting the digital transformation

Table 1. Descriptive statistics and collinearity analysis

variable	N	mean	sd	min	max	VIF	1/VIF
Lndigital	14163	1.241	1.245	0	4.635	-	-
Lnsale	14163	8.706	1.099	5.360	10.33	1.040	0.961
RD	14163	4.661	3.913	0	25.02	1.120	0.894
Size	14163	22.03	1.159	19.93	25.58	1.460	0.683
Age	14163	2.874	0.311	1.946	3.497	1.040	0.958
Lev	14163	0.388	0.194	0.0550	0.939	1.830	0.547
Roa	14163	0.0400	0.0670	-0.299	0.200	3.680	0.272
Roe	14163	0.0590	0.136	-0.810	0.397	3.080	0.324
Stock	14163	0.336	0.140	0.0910	0.714	1.050	0.953

Table 2. Correlation analysis

	Lndigital	Lnsale	RD	Size	Age	Lev	Roa	Roe	Stock
Lndigital	1								
Lnsale	0.23***	1							
RD	0.22***	0.17***	1						
Size	0.10***	−0.05***	−0.19***	1					
Age	0.00	0.02**	−0.10***	0.16***	1				
Lev	0.02***	−0.09***	−0.20***	0.50***	0.12***	1			
Roa	0.01	0.07***	−0.06***	−0.01	−0.06***	−0.41***	1		
Roe	0.03***	0.05***	−0.07***	0.05***	−0.03***	−0.22***	0.81***	1	
Stock	−0.03***	−0.04***	−0.11***	0.09***	−0.06***	−0.02**	0.16***	0.12***	1

Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3. Regression analysis

	(1)	(2)	(3)
Lnsale	0.069***	0.193***	0.062***
	(0.009)	(0.029)	(0.009)
Size	0.177***	−0.149***	0.182***
	(0.009)	(0.030)	(0.009)
Age	−0.146***	−1.016***	−0.112***
	(0.030)	(0.098)	(0.030)
Lev	−0.068	−3.952***	0.067
	(0.061)	(0.195)	(0.061)
Roa	−0.268	−7.971***	0.004
	(0.249)	(0.800)	(0.248)
Roe	0.229**	0.131	0.225**
	(0.111)	(0.358)	(0.110)
Stock	−0.087	−1.223***	−0.045
	(0.065)	(0.208)	(0.064)
RD			0.034***
			(0.003)
_cons	−3.205***	7.642***	−3.465***
	(0.227)	(0.729)	(0.226)
N	14163.000	14163.000	14163.000
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
r2	0.324	0.291	0.332
r2_a	0.322	0.289	0.330

Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

of enterprises; Comparing models (1) and (3), after adding the R&D investment variable, the coefficient decreases from 0.069 to 0.062, but the significance level remains unchanged, indicating that there is an intermediary path of enterprise R&D investment in the positive relationship between e-commerce development level and enterprise digital transformation. Hypothesis 2 is verified.

5 Conclusion

Through collecting the data of the digital transformation of A-share listed manufacturing enterprises and the data of the development level of regional e-commerce, the empirical test found that the development level of regional e-commerce can drive the digital

transformation of manufacturing enterprises. Each region should vigorously strengthen the application of digital technologies such as Internet technology, take e-commerce as the link, cultivate the intelligent manufacturing model with e-commerce as the traction, and drive the digital and intelligent development of manufacturing industry.

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