



The Impact of Supply Chain Management on the Digital Transformation of Chinese Manufacturing Enterprises

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ABSTRACT

To study the interaction of the supply chain and enterprise digital transformation, this article on China's manufacturing industry from 2011 to 2020 3008 listed companies as research samples, through text analysis method to measure the degree of enterprise digital transformation, the supply chain upstream supplier's concentration and how supply chain downstream customer concentration affects manufacturing enterprise digital transformation. The empirical results show that supply chain management has a significant impact on the digital transformation of manufacturing enterprises, and the impact of supply chain characteristics on the degree of enterprise digital transformation is not one-way, that is, it may promote the digital transformation of enterprises, or it may hinder the digital transformation of enterprises: The concentration of upstream suppliers will restrain the digital transformation of enterprises, while the concentration of downstream customers will promote the digital transformation of enterprises. It shows that enterprises should construct suitable digital transformation strategy according to their own characteristics of supply chain and realize digital transformation smoothly.

Keywords: *Supply chain management; Digital transformation; Manufacturing;*

1. INTRODUCTION

With the intensification of global competition and the development of digital economy, digital transformation of enterprises has become the general trend. In addition to emerging digital enterprises, the digital transformation of traditional industries has become the key for a country and enterprises to maintain and obtain competitiveness. Digital transformation will help traditional industries upgrade their business with digital technology, thus increasing production volume and efficiency. This paradigm shift will enable companies to have more comprehensive data to respond to demand, thereby improving productivity.

For all countries in the world, manufacturing is the pillar industry of the national economy. It is of great significance to improve the combination of the new generation of information technology and manufacturing for the development of a country. Facing the new technological change, all countries in the world have formulated the new manufacturing industry development

strategy accordingly. The US government has issued the "Intelligent Manufacturing Revitalization Plan" and "Advanced Manufacturing American Leadership Strategy" to promote the digital transformation of manufacturing industry. The German government has launched the "Digital Strategy 2025" with "Industry 4.0" as the core, hoping to further stimulate the new creativity and competitiveness of the national manufacturing industry.

China's manufacturing industry presents the characteristics of large but not strong and lacks the popularization of information technology. In the process of global digitization, whether we can seize this opportunity to carry out industrial transformation is of far-reaching significance to the development of China's manufacturing industry. The Ministry of Industry and Information Technology proposed in the "Intelligent Manufacturing Development Plan in 14th Five-Year Plan" that the digitalization of manufacturing enterprises above designated size should be completed in 2035. Intelligent Manufacturing Development Index Report (2021) released by China Electronics Technology

Standardization Institute points out that only 23% of Enterprises in China have designed a complete digital transformation plan in terms of digital transformation strategy, lower than 29% in the Asia-Pacific region. The digital transformation of China's manufacturing industry is still in its infancy and studying the factors influencing the digital transformation of manufacturing enterprises at this time will be of great help to the development and progress of the whole industry.

At the same time, in the context of COVID-19, the supply chain resilience of manufacturing enterprises is becoming more and more important for enterprise operations. The smart supply chain based on digital technology will improve the overall response capacity and coordination ability of the supply chain, to help enterprises cope with the supply chain disruption caused by emergencies such as COVID-19, thus helping enterprises gain advantages in the competition of the supply chain. Thus, the construction of intelligent supply chain has also become the core competitiveness of enterprises [16]. The construction of intelligent supply chain will promote the digital transformation of manufacturing enterprises. Therefore, it is of practical significance to study the digital transformation of manufacturing enterprises from the perspective of supply chain. This paper will study how the management of supply chain will affect the digital transformation of enterprises from two aspects of supply chain integration: upstream supplier concentration degree and downstream customer concentration degree.

2. LITERATURE REVIEW AND RESEARCH HYPOTHESIS

2.1 Literature Review

In the study of the impact of digital transformation on enterprises, Zhao proposed that the digital transformation studied in this paper has significantly improved the total factor productivity of enterprises and has become a strong driving force to improve the production efficiency of manufacturing enterprises in the era of digital economy [13]. For the digital transformation of manufacturing industry, most previous studies focused on the digital transformation of manufacturing idea [8], this kind of research is mainly focused on the strategic path to digital transformation of manufacturing industry, the lack of based on the analysis of the data, and to affect the manufacturing digital transformation of quantitative research is less.

Most of the research on supply chain integration focus on the impact of supply chain integration on enterprise performance. Li Fei [6] believes that supply chain integration will improve enterprise operation efficiency and thus enhance enterprise management ability and efficiency. Zhou and Guo proposed that the implementation of supply chain management not only has

a significant direct positive impact on organizational performance, but also has a significant indirect positive impact on organizational performance through competitive advantage [14]. However, there are few studies on the impact of supply chain management on enterprise digitalization. Zhai proposed that supply chain management has a significant impact on the level of enterprise digitalization investment, and the impact is not one-way [12]

Existing studies have preliminarily demonstrated the positive impact of digitalization on enterprises, but there is a lack of research on the factors influencing the digital transformation of manufacturing enterprises, especially for supply chain management and enterprise digital transformation. Therefore, it is of practical significance to study the impact of supply chain integration on the digital transformation of manufacturing enterprises.

2.2 Research Hypothesis

2.2.1 The Influence of Supplier Concentration on Enterprise Digital Transformation

In the supply chain relationship, the upstream supplier is an important stakeholder for the enterprise. The high concentration of upstream suppliers means that enterprises have a close cooperative relationship with some large suppliers. On the one hand, such close cooperation reduces production transaction costs, and on the other hand, enterprises form an invisible contract with these suppliers [5]. This kind of invisible contract causes enterprises to have excessive trust in suppliers. Once the cooperative relationship is terminated, it is difficult for enterprises to find suitable alternative suppliers, which will cause enterprises to fall into the operation risk of lack of upstream raw materials. At the same time, digital transformation, as a kind of technological innovation, is a business activity that requires high-risk and long-term capital investment [7]. Therefore, for enterprises with high concentration of upstream suppliers, they will reduce the operational risks caused by high concentration of suppliers by reducing the investment in technological innovation. The process of technological innovation in digital transformation will slow down due to the reduction of available capital.

Therefore, hypothesis 1 is proposed: H1: The higher the concentration of upstream suppliers, the lower the degree of digital transformation of enterprises.

2.2.2 The Impact of Customer Concentration on Enterprise Digital Transformation

Stable downstream customers can ensure the smooth operation of enterprises, improve their operating conditions, and reduce their operating risks and capital costs [3]. At the same time, stable supply chain relationships will make banks believe that enterprises

have more reliable development prospects, thus enhancing the willingness of banks to lend to enterprises [9]. This enables downstream enterprises with stable supply chains to get more capital from banks to invest in technological innovation. At the same time, Anderson et al. (2002) believed that the transaction relationship between enterprises and customers would promote the information sharing between them [1]. The market demand and technical experience brought by such information sharing will become the power and advantage to stimulate enterprises' technological innovation, which will reduce the obstacles of enterprises' technological innovation and make it easier to achieve the goal of technological innovation. Therefore, hypothesis 2 is proposed: H2: The higher the concentration of downstream customers, the higher the degree of digital transformation of enterprises.

3. DATA SOURCES AND VARIABLE DESCRIPTION

3.1 Data sources

This paper uses data of Chinese manufacturing enterprises to study the influencing factors of digital transformation from the perspective of supply chain management. According to the 2020 National Manufacturing Digitization Ranking compiled by Bloom-Berg, China is leading the way in manufacturing digital transformation and application of digital technology. In 2019, China's manufacturing imports and exports accounted for 58.3 percent and 93.06 percent of the country's total imports and exports of all goods. Meanwhile, China has become the center of the global manufacturing supply chain network in 2017. Therefore, China's manufacturing industry is a suitable sample to study the impact of supply chain management on the digital transformation of manufacturing industry.

In this paper, 3,008 enterprises that were listed in Shanghai Stock Exchange or Shenzhen Stock Exchange from 2011 to 2020 and classified as manufacturing enterprises according to "the Guidance on Industry Classification of Listed Companies revised" by China Securities Regulatory Commission (CSRC) in 2012 are used as research samples. The sample panel data used are from the China Stock Market Accounting Research (CSMAR) database. On this basis, the sample panel data are further processed:

Firstly, ST companies should be excluded because the operation of these companies has been abnormal. If the data of these companies are included in the research sample, the effect of the whole research may be caused. The second is to eliminate the samples with missing and

abnormal data to prevent the influence of missing and abnormal data on the research.

According to the above screening principles, a total of 9334 groups of panel data of 1596 listed manufacturing enterprises from 2011 to 2020 were finally obtained. This paper uses EXCEL and Stata 17.0 software for statistical collation and analysis of sample data.

3.2 Variable Description

The explained variable in this paper is the degree of digital transformation, and content analysis method is adopted to measure the degree of enterprise digital transformation. Content analysis method is a research method to carry out effective data inference through the content of the text, that is, the frequency of certain words in the text is counted to reflect the researchers' attention to such problems and the expression of intention [4]. The degree of digital transformation of an enterprise is measured by counting the number of occurrences of the words related to the application of artificial intelligence technology, blockchain technology, cloud computing technology, big data technology and digital technology in enterprise reports. The more words related to digitalization, the higher the degree of digitalization of the enterprise. The data of occurrence times of all digitized words are from the CSMAR database, and the occurrence times of all digitized related words are added up to measure the overall degree of digital transformation of enterprises.

The measurement of supply chain integration is based on two explanatory variables: upstream supplier concentration degree and downstream customer concentration degree.

The core explanatory variables of this paper are upstream supplier concentration and downstream customer concentration. Referring to the research of Bernhard Geissler, Michael C. Mew and Gerald Steiner [2], upstream supplier concentration adopts supplier Herfindahl index, that is, the sum of the square of the purchase amount of the top five suppliers in the total sales ratio, and downstream customer concentration adopts customer Herfindahl index. That is, the top five customer sales accounted for total sales squared sum.

The control variables in this paper are profitability, capital structure, R&D investment, firm size and firm age. Capital structure and profitability have an important impact on the innovative application of enterprises [15]. R&D investment also has an important impact on the technological innovation and performance of enterprises [10]. As a factor affecting enterprise behavior, enterprise age plays an important role in regulating enterprise innovation investment [11].

Table 1: Variable names, symbols, and meanings

Variable types	Variable name	Variable symbol	Variable meaning
Explained variable	Degree of digital transformation	DT	The total number of occurrences of digitalization related words
Explanatory variables	Supplier Herfindahl index	SC-HHI	The sum of the top five suppliers' purchases in total sales ratio squared
	Customer Herfindahl index	CC-HHI	The top five customer sales are the sum squared of total sales
Control variables	Net profit margin on total assets	ROA	Net profit/annual average total assets
	The enterprise scale	InSize	Take the logarithm of the total assets at the end of the period
	The capital structure	Lev	Ratio of Total Ending Liabilities to Total Ending Assets (%)
	Enterprise age	Age	The difference between the closing year and the year when the company was founded
	R&D Investment	RD	R&D investment as percentage of revenue (%)

4. EMPIRICAL RESULTS AND ANALYSIS

4.1 Descriptive Statistics

Table 2 shows the descriptive statistical results for the main variables. As can be seen from the table, the minimum value of digital transformation degree of all sample enterprises is 0, the maximum value is 463, and the standard deviation is 18.915, indicating that the

degree of digital transformation degree of the whole industry is very different. And the median degree of digital transformation is 1, indicating that most enterprises have only carried out a minimal degree of digital transformation. At the same time, the difference between the minimum and maximum values of supplier concentration Herfindahl index and customer concentration Herfindahl index is obvious. Descriptive statistics indicate that the differences between samples are large enough to facilitate empirical research.

Table 2: Descriptive statistics of variables

The Variable	Number of Samples	The Average	The Standard Deviation	The Minimum	The Maximum	The Median
DT	19175	6.71	18.92	0.00	463.00	1
SC-HHI	11632	5.29	8.82	0.00	100.00	2.36
CC-HHI	14167	5.01	9.09	0.00	106.21	1.76

LnSize	19198	21.92	1.20	16.65	27.55	21.76
R&D	12915	16.42	117.71	0.00	11066	3.84
ROA	19198	0.04	0.46	-48.32	22.01	0.04
Age	14663	17.21	5.88	1.33	55.67	17.08
Lev	19198	0.41	0.64	0.01	63.97	0.38

4.2 Multiple Regression Analysis

Since the enterprise data varied from year to year, the fixed-effects model was used for regression. According to the results of regression (table 3), Herfindahl, index of concentration of suppliers on the digital transformation influence significantly at the 1% level is negative, supplier concentration Herfindahl index per 1 unit, the transformation of digital level fell by 0.1108 units, that the supplier's highly concentrated against digital transformation of enterprise, consistent with hypothesis H1. The influence of Customer concentration Herfindahl index on the degree of digital transformation is significantly positive at the level of 1%. When the Customer concentration Herfindahl index increases by 1 unit, the degree of digital transformation of enterprises increases by 0.0917 units, indicating that the high concentration of customers is conducive to the enterprise's digital transformation, which is consistent with hypothesis H2.

From the measurement results, the upstream and downstream of the supply chain demand for enterprise digital transformation is completely opposite. This is because enterprises in different positions have different needs for digitization. Enterprises are in cooperation with upstream suppliers, and they need to present a stable operating state to obtain stable supply channels from upstream suppliers. Too much input in digital transformation will affect this relationship. When an enterprise cooperates with downstream customers, customer demand will become the dominant factor of enterprise operation behavior. Digital transformation will enable enterprises to better understand customer demand, which will promote the digital transformation of enterprises.

Table 3: Influence of supply chain integration on digital transformation

	DT
CC-HHI	0.0917*** (0.0335)
PC-HHI	-0.1108*** (0.0325)
ROA	1.0613 (1.4895)
lnSize	2.5793***

	(0.2403)
Lev	1.0350 (1.1172)
Age	0.1326*** (0.0426)
RD	-0.0091 (0.0287)
Constant	-52.2103*** (5.3661)
Number of observations	9334
Fixed effect model	Yes
Adjusted R ²	0.0218

Note: Parentheses are standard error for variables; *, ** and *** represent significant at 10%, 5% and 1% levels respectively

4.3 Robustness Test

In order to test the reliability and accuracy of the research results, this paper introduces two missing variables, profit growth rate and intangible asset proportion. The profit growth rate reflects the growth of enterprises. A high profit growth rate can ensure that enterprises have enough capital space to invest in technological innovation and better complete digital transformation. A high proportion of intangible assets of an enterprise means that many assets of the enterprise are represented by certain legal rights or technologies. The high technology of such enterprise is more conducive to digital transformation. Two missing variables were introduced to test again, and the test results were consistent with the above results.

5. RESEARCH CONCLUSIONS AND IMPLICATIONS

5.1 Research Conclusions

By taking 3003 enterprises in China's manufacturing industry from 2011 to 2020 as research samples, this paper conducts an empirical study on the impact of supply chain management on the digital transformation of manufacturing industry and finds that: The integration of supply chain has a significant impact on enterprises' digital transformation. Meanwhile, different

characteristics of supply chain concentration degree have opposite effects on enterprises' digital transformation. Highly centralized supplier relationship will inhibit enterprises' digital transformation, while high customer concentration will promote enterprises' digital transformation.

This paper broadens the research dimension of factors affecting enterprise digital transformation and analyzes enterprise digital transformation from the perspective of supply chain management. At the same time, this paper adopts text analysis method to identify the degree of enterprise digital transformation, and objectively quantifies the level of enterprise digital transformation under the existing conditions. The existing literature mostly uses questionnaire survey to study the factors affecting enterprise technological innovation, while the text analysis method adopted in this paper can be complementary to the questionnaire survey method to quantify the degree of enterprise digital transformation.

5.2 Implications

The research findings of this paper also have some implications: To build stable supply relationships with suppliers, enterprises often choose to reduce their own input in technological innovation, which slows down the progress of enterprises' digital transformation process. This requires the enterprise to have a long-term strategic deployment, should not sacrifice the digital transformation of industrial upgrading in exchange for a short period of stable supply relations brought benefits. At the same time, enterprises should not only passively accept the demands of upstream suppliers, but also take the initiative to provide more diversified demand designs for upstream suppliers by virtue of the advantages in resource innovation and information exchange gained from digital transformation after completing digital transformation. In addition, due to the research results show that the height of the customer focus will promote the digital transformation of enterprises, enterprises should have more downstream supply chain integration ability, for the customer, this is helpful to get more personalized service, at the same time for the enterprise itself, stable relations of cooperation, this could improve the management efficiency of enterprises.

5.3 Limitations

This paper also has some limitations: First, the measurement of the degree of enterprise digital transformation is based on text analysis, which cannot accurately represent the degree of enterprise digital transformation. Secondly, this paper only studies the impact of supply chain on enterprise digital transformation from the perspective of supply chain concentration, and more supply chain characteristic indicators are needed. Finally, this paper only studies the

relationship between supply chain and enterprise digital transformation in terms of data, which cannot specifically reflect the behavior of specific enterprises. In the future, it can study more relevant enterprise actual cases to complement the measurement method in this paper.

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