



Research on the Impact of Digital Transformation on the Resilience of Manufacturing Enterprises

Xuexue Wang

School of Economics, Anhui University, Hefei, 230601, China

13635644597@163.com

Abstract. In the context of the continuous rise in the external environment uncertainty and the pressure of the domestic market recovery, improving the ability around resilience has become a top priority for enterprises. This paper takes the data of A-share manufacturing listed companies from 2012 to 2022 as a sample to investigate the impact of digital transformation on enterprise resilience. The study found that digital transformation can enhance the resilience of enterprises and promote the sustainable development of enterprises.

Keywords: digital transformation; Manufacturing; Enterprise toughness.

1 Introduction

Digital transformation refers to the integration of data through Internet, big data, cloud technology, artificial intelligence and other digital technologies after business data processing to achieve risk control and efficiency improvement^[1], which is an important link in the development process of digital economy. The process of digital transformation includes not only technical improvements, but also fundamental reshaping of management structures and business processes^[2].

Manufacturing is a pillar industry of the national economy, and its digital transformation shoulders the dual mission of technological innovation and promoting high-quality economic development. Digital transformation of the manufacturing industry refers to the integration of digital technology and business processes to improve production efficiency, optimize resource allocation, and improve product quality. Through digital transformation, the traditional production and operation model, organizational structure model, decision-making management model, supply chain collaboration model and innovation model of the manufacturing industry will all change. This process promotes the transformation of the vertical industrial structure into a flat one, forms a new manufacturing ecosystem, promotes coordinated industrial development, and realizes the upgrading and transformation of the manufacturing production model.

Initially, the concept of "toughness" was widely used in the fields of physics and materials science to describe the ability of materials to recover after deformation under

the action of external forces. Since then, the concept of “resilience” has gradually expanded to other disciplines, including psychology, economics, and sociology. As for the definition of enterprise resilience, the academic community has not yet reached a clear conclusion. Gallopin believes that enterprise resilience refers to the adaptability and resilience shown by enterprises in the face of various emergencies and persistent pressure^[3]. Sanchis et al. define enterprise resilience as the ability of enterprises to adapt to and recover from shocks when affected by negative events^[4].

Digital transformation has promoted the close integration of digital technology and production development, which has made significant changes in the production mode of enterprises. The manufacturing industry is the lifeline of the national economy. Studying how to improve the resilience of manufacturing enterprises through digital transformation plays an important role in improving the comprehensive national strength of the country, ensuring national security and building a world power, but there are few literatures to study this.

In view of this, this article studies the impact and mechanism of digital transformation on enterprise resilience. The possible contributions are: (1) From a multi-dimensional perspective, the entropy method is used to use the comprehensive level of resistance and recovery capabilities as an indicator of enterprise resilience, which expands the scope of enterprise resilience. A measure of toughness. (2) This article takes the data of A-share manufacturing listed companies from 2012 to 2022 as the research object, starting from both theoretical and empirical levels, and systematically studies the mechanism of the digital transformation of manufacturing enterprises on corporate resilience, and provides guidance for the digitalization of manufacturing enterprises in my country. Transformation provides new empirical evidence.

2 Theoretical Analysis

The academic community is still exploring the relationship between enterprise digital transformation and enterprise resilience, and most scholars hold the same view that digital transformation has a positive impact on enterprise resilience.

On the one hand, digital transformation improves the ability of enterprises to respond to external shocks. Hu Haifeng and others found that digital transformation can significantly improve corporate resilience, as evidenced by higher stock returns during crisis periods for digitalized firms^[5]. Organizational resilience is an important part of enterprise resilience, which reflects the core ability of enterprises to cope with crises in changeable, complex and ambiguous situations^[6]. On the other hand, digital transformation has a significant role to play in promoting the sustainable development of enterprises. By introducing advanced digital technologies, digital transformation optimizes business processes and improves work efficiency^[7]. Digital transformation can also improve the quality of internal control and further enhance the sustainable development capability of enterprises^[8]. Based on this hypothesis, digital transformation can effectively improve enterprise resilience.

3 Research Design

3.1 Model Design

First, to explore whether enterprise digital transformation can enhance enterprise resilience, the measurement model is constructed as follows:

$$\text{Score}_{it} = \beta_0 + \beta_1 \text{Digit}_{it} + \gamma \text{Controls}_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Score, Digit, and Controls respectively represent the enterprise resilience of the explained variable, the enterprise digital transformation index of the core explanatory variable, and a series of enterprise-related control variables. And represent individual fixed effects and time fixed effects, respectively, and ε_{it} represents random errors. The parameters express the degree of impact of enterprise digital transformation on enterprise resilience. Further, this paper examines the impact mechanism of enterprise digital transformation on enterprise resilience, and introduces intermediate variables in the benchmark regression. The model is as follows:

$$M_{it} = \alpha_0 + \alpha_1 \text{Digit}_{it} + \gamma \text{Controls}_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$\text{Score}_{it} = \beta_0 + \beta_1 \text{Digit}_{it} + \beta_2 M_{it} + \gamma \text{Controls}_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (3)$$

Where, M is the intermediary variable, namely the financing constraint (sa) and innovation capability (inv) of the enterprise, and other letters have the same meanings as the above formula (1).

3.2 Index Selection

Explained Variables. This paper uses earnings per share and cumulative operating income growth over three years to measure resilience and resilience, respectively. Earnings per share is an important financial indicator to measure the company's performance, which reflects the company's operating status, profitability and investment value. The cumulative growth of operating income in three years can reduce the impact of short-term fluctuations and more accurately assess the long-term business situation of the enterprise. The greater the cumulative growth of operating income in the last three years, the stronger the competitiveness of the enterprise in the market and the ability to respond to external shocks accordingly. Such operating flexibility can enable the company to recover quickly and develop steadily.

Core Explanatory Variables. This paper draws on the research methods of Wu Fei et al.^[9] and Zhao Chenyu et al.^[10], takes artificial intelligence, big data and cloud meter as characteristic keywords, and obtains the total word frequency after word frequency statistics, so as to establish an index system to measure the digital transformation of enterprises. Then, according to the characteristics of the data, the total word frequency is log-plus.

The Intermediary Variable. SA index is based on the calculation method of company size and age, high externality and quadratic function form, and has shown high effectiveness and reliability in measuring corporate financing constraints. Referring to the research of Luo Ziyuan et al.^[11], this paper selects the SA index to measure the degree of corporate financing constraints (sa).

The number of patent applications of enterprises reflects the level of science and technology and R&D strength of enterprises to a large extent, reflecting their efforts and achievements in science and technology research and development, and is an important indicator to measure the innovation ability of enterprises. In this paper, referring to the research of Yu Changlin et al.^[12], the number of invention patents applied by an enterprise separately represents the enterprise innovation capability (inv).

Control Variables. In order to better fit the model, with reference to domestic and foreign literatures, the following variables are selected as control variables in this paper: asset-liability ratio (lev), management expense ratio (mfee), cash flow (cfo1), board size (board), proportion of independent directors (indboard) and management shareholding ratio (mhold).

3.3 Sample Selection and Data Sources

This paper selects the data of A-share manufacturing listed companies from 2012 to 2022 as research samples, and the data are from the CSMAR and Wind databases. The data are processed as follows: 1. ST enterprises are excluded; 2. In order to mitigate the influence of outliers, 1% winsor tail reduction is performed on continuous variables; 3. Remove samples with missing values of core variables.

4 Empirical Results and Empirical Analysis

Table 1 shows the regression results of the impact of enterprise digital transformation on enterprise resilience.

Table 1. Benchmark regression

| | (1) Score | (2) Score |
|-------|--------------------|-----------------------|
| Digit | 0.223** (2.021) | 0.253** (2.280) |
| lev | | 3.641*** (4.710) |
| mfee | | 1.750 (0.696) |
| cfo1 | | -5.013*** (-3.985) |
| board | | -1.201* |

| | | |
|----------------|-----------|-----------|
| | | (-1.662) |
| indboard | | 0.602 |
| | | (0.309) |
| mhold | | -2.055*** |
| | | (-2.788) |
| _cons | 87.499*** | 88.950*** |
| | (314.928) | (43.500) |
| N | 19095 | 19093 |
| R ² | 0.334 | 0.336 |
| F | 4.085 | 8.138 |

In column (1), only the bidirectional fixed effects of individuals and time are included in the econometric model, and the results show that the regression coefficient of digital transformation on firm resilience is 0.223, which is statistically significant at the significance level of 5%. This shows that digital transformation has a significant contribution to the resilience of manufacturing companies. When control variables are added to column (2) the regression coefficient is 0.253 and is significant at at least 5%, further confirming that digital transformation can enhance enterprise resilience. At the same time, R² has also been improved to a certain extent, indicating that the model is more accurate after adding control variables. Therefore, accelerating the digital transformation of enterprises can effectively improve the resilience of enterprises. The hypothesis is tested.

From the perspective of control variables, a higher debt ratio often represents larger enterprise size, stronger resource acquisition capabilities, and robust organizational structures and management mechanisms. These characteristics typically enable companies to keenly detect changes in the external environment and quickly mobilize resources to adjust strategies to cope with market fluctuations and uncertainties. This flexibility and adaptability help companies mitigate potential negative impacts from external shocks, ensuring stable operations and long-term development. The size of the board of directors and the proportion of shares held by management have a negative impact on corporate resilience, indicating that the size of the board or its governance capabilities may weaken the company's ability to withstand external risks. This may reflect that in certain situations, a larger board could lead to reduced decision-making efficiency or governance issues, thereby weakening the company's response capability to sudden events. Management with a high shareholding ratio may focus more on short-term gains and tend to take greater risks, making the company more vulnerable to negative impacts when facing external shocks.

5 Research Conclusions and Suggestions

5.1 Research Conclusions

This paper takes the data of A-share listed manufacturing companies from 2012 to 2022 as A sample to investigate the impact of digital transformation on the resilience of manufacturing enterprises. The study found that enterprise digital transformation significantly improved enterprise resilience.

5.2 Policy Suggestions

First, for the government, first of all, accelerate the establishment of data element empowerment system, coordinate the construction of urban computing power network and data circulation and utilization infrastructure, and promote the digital transformation and intelligent management of public facilities. Second, the government should reduce the cost of enterprise transformation by increasing fiscal and tax support, while improving the digital infrastructure and operating environment of the manufacturing industry, such as the construction of new digital infrastructure such as 5G base stations and data centers. Finally, the government should encourage enterprises to adopt cloud computing and information technology, concentrate resources on cloud platforms, improve production efficiency, management efficiency, business collaboration and resource allocation capabilities, and facilitate the development of new data-driven ecosystems.

Second, for enterprises, first of all, accelerate the construction of digital infrastructure. Enterprises should increase investment in digital technology, improve information systems and data management platforms, and ensure that they can respond quickly when a crisis comes. Digital infrastructure is a core enabler of corporate resilience and should be a strategic priority. Second, cultivate digital talents. Enterprises should attach importance to the cultivation and introduction of digital talents, and build a high-quality team that understands both technology and management to support the digital transformation of enterprises. The digital literacy of employees will directly affect the resilience and innovation of enterprises. Finally, improve the risk management mechanism. In the process of digital transformation, enterprises should improve their risk management mechanisms, especially in the area of data security and privacy protection, to ensure that the benefits of digitalization are not offset by potential risks.

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