# The Influencing Factors and Realization Path of Manufacturing Transformation and Upgrading in Northeast China Driven by Digital Economy

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**Abstract**—Under the strategy of revitalizing northeast China, based on the constructed index system, this paper explores the influence mechanism of digital economy promoting the transformation and upgrading of manufacturing industry, intuitively shows the realization path of digital economy driving the transformation and upgrading of manufacturing industry, and tests its specific mechanism through empirical model.

**Keywords**- digital economy; manufacturing industry; influencing factor; realization path

## 1. Introduction

At present, China's economic growth is in the key link of the transformation of old and new kinetic energy, and the traditional manufacturing industry is facing the dual problems of overcapacity and insufficient effective demand [1]. Since the 19th National Congress of the Communist Party of China, China has repeatedly pointed out that it is necessary to accelerate the development of digital economy and promote the development of manufacturing industry towards digitalization, networking and intelligence. The manufacturing industry in the three eastern provinces has a complete and solid foundation, but its technological level is relatively backward and technological innovation is insufficient, which leads to the slow development of the manufacturing industry. In this context, seizing the development opportunity of digital economy, accelerating the deep integration of digital economy and manufacturing industry in the three eastern provinces, and driving the transformation and upgrading of manufacturing industry in the three eastern provinces are the key to the revitalization of Northeast China.

## 2. Mechanism Analysis and Research Hypothesis

### 2.1 Digital Economy and Manufacturing Transformation and Upgrading

The digital infrastructure is the physical level required for the development of the digital economy. It helps in all aspects of data collection, information transfer and production execution. The digital infrastructure can convey the individual needs of consumers in real time, and

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promote manufacturing enterprises to provide products needed by consumers based on their actual needs. The development of digital infrastructure has also prompted enterprises to reorganize the internal management structure, making the traditional manufacturing industry gradually intelligent. From the perspective of industry, digital infrastructure construction has helped the industry break the space constraints, and real-time information transmission has helped the manufacturing industry to form a cluster innovation advantage to a certain extent [2]. Therefore, the first hypothesis is proposed: the digital economy has a positive effect on the transformation and upgrading of manufacturing industry.

### 2.2 Digital Economy and Resource Allocation of Manufacturing Enterprises

Technological change led by the digital economy has revolutionized the way companies collaborate, improved their resource allocation capabilities, driven the upgrading of business performance [3]. The construction of digital infrastructure has improved the coordination level of production factors within the industry, improved production efficiency and resource utilization, and is of great significance to the development of traditional manufacturing. The development of digital economy breaks the limitation of time and space and realizes the reasonable allocation of human resources. With the advent of the digital economy, informatization enables enterprises to quickly grasp industry trends, constantly updated intelligent manufacturing also provides technical support for enterprise development, effectively helping the transformation and upgrading of enterprise manufacturing structure. Therefore, the second hypothesis is proposed: digital economy promotes manufacturing transformation and upgrading by improving enterprise resource allocation capability.

### 2.3 Digital Economy and Innovation Ability of Manufacturing Enterprises

Digital technology is the main engine driving the development of the digital economy, which makes the distance and boundary between consumers and producers decreasing, forcing enterprises to achieve innovation and upgrading [4]. Digital technology is widely used in information processing, communication and intelligent upgrading of production methods in manufacturing enterprises. It transforms all aspects of traditional manufacturing production and makes intelligent manufacturing become the mainstream manufacturing method. At the same time, the R & D department of manufacturing enterprises accelerates its internal technological innovation, forms a learning effect, guarantees the output of innovation programs, and realizes the vertical and horizontal expansion of the existing technological resource utilization capabilities of enterprises. Therefore, the third hypothesis is proposed: digital economy promotes manufacturing transformation and upgrading by improving enterprise innovation capability.

### 2.4 Digital Economy and Enterprise Production Cost

For manufacturing enterprises, the cost-income ratio is an important basis for measuring industrial upgrading [5]. Manufacturing enterprises can reduce the cost of information acquisition between enterprises by using information and communication technology, and can purchase raw materials at the lowest cost. At the same time, digital technology is gradually applied to various fields of manufacturing industry, broadening the channels of understanding information and reducing information asymmetry in the decision-making process. The research results of relevant scholars show that the digital transformation of traditional entity manufacturing enterprises improves business performance by reducing costs and improving efficiency, and improves the ' double high ' problem of traditional manufacturing costs and energy consumption. Therefore,

the fourth hypothesis is proposed: digital economy drives the transformation and upgrading of manufacturing industry by reducing production costs.

## 3. Variable Selection and Model Design

### 3.1 Measurement Method

Drawing on previous studies, entropy method is an objective weighting method with relatively high accuracy. This paper uses this method to measure the level of digital economy and manufacturing upgrading.

### 3.2 Measurement and Analysis

At present, the measurement of the development level of digital economy at home and abroad is different. Based on the research results of relevant scholars, this paper constructs the index system of digital infrastructure development level, digital industry development level and digital social application level. Regarding the level of manufacturing transformation and upgrading, this paper constructs a manufacturing transformation and upgrading index of three dimensions: production scale, research innovation, energy conservation and environmental protection.

Table 1 Index System of Digital Economy Development Level

| **First Index** | ***Second index*** | ***Indicator description*** |
|---|---|---|
| digital basic development level | Number of mobile phone users | Unit: People |
| | Internet broadband access users | Unit: ten thousand households |
| | Optical cable line length | Unit: piece |
| development level of digital industry | The number of urban unit employment in information service industry | Unit: ten thousand people |
| | Information technology service income | Unit: ten thousand yuan |
| | Software business income | Unit: ten thousand yuan |
| application level of digital society | E-commerce sales | Unit: 100 million yuan |
| | E-commerce purchase amount | Unit: 100 million yuan |
| | Digital Inclusive Finance Development | / |

Table 2 Index System of Manufacturing Transformation and Upgrading Level

| **First Index** | ***Second index*** | ***Indicator description*** |
|---|---|---|
| Scale of production | Number of industrial enterprises | Unit: piece |
| | value added | Unit: 100 million yuan |
| research innovation | R&D expenditure of industrial enterprises above designated size | Unit: ten thousand yuan |

| First Index | *Second index* | *Indicator description* |
|---|---|---|
| | Number of effective invention patents of industrial enterprises above designated size | Unit: piece |
| energy saving and environmental protection | energy consumption per unit GDP | comprehensive energy consumption/GDP |
| | electricity consumption for GDP | industrial electricity consumption/GDP |

According to the index system of digital economic development level and manufacturing transformation and upgrading level constructed in the table, the entropy method is used to measure, and the comprehensive index representing the level of digital economic development and manufacturing transformation and upgrading is obtained. The specific data for Jilin, Heilongjiang and Liaoning are shown in Table.

Table 3 Development Level of Digital Economy and Transformation and Upgrading Level of Manufacturing Industry from 2015 to 2020

| Year | Jilin | | Heilongjiang | | Liaoning | |
|---|---|---|---|---|---|---|
| | ***Development level of digital*** | ***Transformation and upgrading*** | ***Development level of digital*** | ***Transformation and upgrading*** | ***Development level of digital*** | ***Transformation and upgrading*** |
| 2015 | 0.5867 | 0.694 | 0.687 | 0.536 | 0.749 | 0.606 |
| 2016 | 0.610 | 0.773 | 0.784 | 0.663 | 0.572 | 0.575 |
| 2017 | 0.663 | 0.7611 | 0.946 | 0.748 | 0.5792 | 0.6479 |
| 2018 | 0.9412 | 0.814 | 0.363 | 0.608 | 0.659 | 0.698 |
| 2019 | 0.842 | 0.645 | 0.447 | 0.771 | 0.725 | 0.761 |
| 2020 | 0.926 | 0.782 | 0.452 | 0.975 | 0.745 | 0.888 |

## 3.3 Variable and Declaration

### 3.3.1 Control variable

Referring to existing research, the control variables are the level of economic development (RGDP), foreign investment (FDI), government investment (GI), industry size (IC). Among them, per capita GDP is used to represent the level of economic development, foreign direct investment is used to represent foreign investment, local fiscal general public budget expenditure is used to represent government investment, and the proportion of industrial added value in GDP is used to represent the scale of industry.

### 3.3.2 Mediator Variable

According to the mechanism analysis, the digital economy promotes the transformation and upgrading of manufacturing enterprises by improving the resource allocation ability, improving

the innovation ability, information matching efficiency and reducing the production cost of manufacturing enterprises. Therefore, resource allocation ability (RAA), innovation ability (IA) and production cost (COST) are selected as mediating variables to examine the mechanism of digital economy affecting manufacturing upgrading.

### 3.4 Variable and Declaration

To test the above hypotheses, the following dynamic model is constructed:

$$MA_{it} = a + +a_1 DE_{it} + a_2 GRGDP_{it} + a_3 GI_{it} + a_4 FDI_{it} + a_5 IC_{it} + \varepsilon_{it} \quad (1)$$

Among them, i represents the three northeastern provinces (i= 1,2,3), t represents the year ( t = 2015,2012,..., 2020 ). $MA_{it}$ represents the manufacturing upgrading level of i province in t year, and $DE_{it}$ represents the digital economy development level of i province in t year. RGDP, GI, FDI and IC represent the level of economic development, government investment, foreign investment and industry scale in turn. $\beta_0$ is a constant term, $\beta_1 - \beta_5$ are estimated coefficients for each variable, ε_it is a random error term.

Referring to the practice of Zhonglin Wen et al. (2004) [6], the mediating effect is tested by sequential test. The specific model is constructed as follows:

$$MA_{it} = \alpha_0 + \alpha_1 DE_{it} + \alpha_2 Control_{it} + \mu_{it} \quad (2)$$

$$W_{it} = \beta_0 + \beta_1 DE_{it} + \beta_2 Control_{it} + \sigma_{it} \quad (3)$$

$$MA_{it} = \gamma_0 + \gamma_1 W_{it} + \gamma_2 DE_{it} + +\gamma_3 Control_{it} + \varphi_{it} \quad (4)$$

Three measurement equations are used to observe the mediating mechanism of digital economy affecting the transformation and upgrading of manufacturing industry.

## 4. Empirical Test

### 4.1 Analysis of Basic Regression Results

OLS regression was performed on all samples using Stata software. Most variables passed the significance test. The $R^2$ value is 0.5756, and the model fit was good. The results show that after controlling the variables of RGDP, FDI, GI, and IC, the regression coefficient of the digital economy is 0.1644 and passes the 5% significance level test. It shows that the development level of digital economy in the three northeastern provinces is positively correlated with the transformation and upgrading of manufacturing industry, that is, the level of digital economy has a positive effect on the transformation and upgrading of manufacturing industry, and Hypothesis 1 is verified to be true.

Table 4 Basic Regression Results

| Variable | ***Estimated coefficient*** | ***p*** | Variable | ***Estimated coefficient*** | ***p*** |
|---|---|---|---|---|---|
| DE | 0.1644 | 0.037 | GI | -1.6515 | 0.596 |
| RGDP | 2.5876 | 0.041 | IC | -3.1599 | 0.014 |
| FDI | 0.5258 | 0.795 | | | |
| $R^2$ | 0.5756 | | F | 44.7 | |

## 4.2 Mediation Effect Analysis

According to the intermediary effect model in formula (2) - (4), RAA, IA and COST variables are used to replace the intermediary variable W in the model, and the intermediary effect test is carried out from the three paths of 'digital economy development-resource allocation ability-manufacturing upgrading', 'digital economy development-innovation ability-manufacturing upgrading' and 'digital economy development-production cost-manufacturing upgrading'. The final results are shown in the Table.

Table 5 Test Results of Mediating Effect of Digital Economy on Manufacturing Upgrading0

| **Variable** | **MA** | **Mesomeric effect** | | | | | |
|---|---|---|---|---|---|---|---|
| | | ***RAA*** | ***MA*** | ***IA*** | ***MA*** | ***COST*** | ***MA*** |
| RAA | | | 0.8279<br>(0.039) | | | | |
| IA | | | | | 0.80<br>(0.018) | | |
| COST | | | | | | | -1.039<br>(0.001) |
| DE | 0.16<br>（0.037<br>） | 0.15<br>(0.039) | 0.039<br>(0.033) | 0.1686<br>(0.041) | 0.35<br>(0.015) | -0.0793<br>(0.047) | 0.3261<br>(0.003) |
| $R^2$ | 0.5756 | 0.9758 | 0.6814 | 0.9257 | 0.7504 | 0.9126 | 0.8512 |
| F | 44.7 | 96.8 | 64.2 | 29.9 | 69.1 | 25.05 | 10.49 |
| Mesomeric effect<br>Total mediating effect | | Mesomeric effect =0.1253<br>Total mediating effect =0.7621 | | Mesomeric effect =0.1345<br>Total mediating effect =0.8179 | | Mesomeric effect =0.0966<br>Total mediating effect =0.5876 | |

The results show that the coefficient of DE variable is positive. Columns 2 and 3 are used to test whether there is a mediating effect of resource allocation capability. The results show that the level of digital economy can improve the resource allocation ability of enterprises. Enterprise resource allocation capacity is positive to the level of manufacturing upgrading, that is, to improve enterprise resource allocation capacity to promote manufacturing transformation and upgrading. There is a significant partial mediating effect of resource allocation ability, accounting for 0.7621 of the total effect, indicating that the mediating effect of resource allocation ability

is more obvious. Therefore, it can be concluded that Hypothesis 2 is true. Columns 4 and 5 are used to test whether there is a mediating effect of innovation capability. The results show that the level of digital economy can improve the innovation ability of enterprises. The innovation ability of enterprises is positive to the upgrading level of manufacturing industry, that is, improving the resource allocation ability of enterprises to promote the transformation and upgrading of manufacturing industry. The results a, b and c are significant, so there is a significant partial intermediary effect of enterprise innovation ability, accounting for the proportion of the total effect is 0.8179, indicating that the degree of intermediary effect of innovation ability is more obvious, so hypothesis 3 is true. Columns 6 and 7 are used to test whether there is a production cost intermediary effect. The results show that the level of digital economy can reduce the production cost of enterprises. The production cost of this enterprise has a significant partial mediating effect, accounting for 0.5876 of the total effect, indicating that the mediating effect of the production cost of the enterprise is more obvious. Therefore, it can be concluded that Hypothesis 4 is true.

## 5. Conclusion and Suggestion

Comprehensive research results, the digital economy has a certain role in promoting the transformation and upgrading of the manufacturing industry. Under the strategy of revitalizing northeast China, how to better play the driving role of the digital economy to empower the transformation and upgrading of the manufacturing industry is an urgent issue to be resolved at present.

### 5.1 Continuing to consolidate the foundation of digital economy technology facilities

The development level of digital economy in the three northeastern provinces is at a medium level in China. In order to make better use of the historical foundation of the manufacturing industry in the three northeastern provinces, the government should continuously optimize the development link of digital transformation, guide manufacturing enterprises to focus on technological innovation, establish intelligent platforms, and focus on building industrial production and service systems with intelligent application integration platforms as the core, and optimize and upgrade the manufacturing production process.

### 5.2 Exploring a New Model of Deep Integration of Digital Economy and Manufacturing Industry

The government should guide manufacturing enterprises to focus on the integration of information technology and traditional production mode, so that enterprises can accelerate internal innovation, break through the bottleneck of production technology, and promote the deep integration of digital economy and manufacturing industry. At the same time, establish a government-level technology exchange platform to jointly explore a new model of deep integration of the digital economy and manufacturing. Manufacturing enterprises should actively introduce digital technology, pay attention to the integration of information technology and traditional production mode, accelerate internal innovation and break through technical bottlenecks.

### 5.3 Pay Attention to Technological Innovation Development of Enterprises

Paying attention to enterprise technology innovation is an inevitable choice for the transformation and upgrading of manufacturing enterprises. The government side provides a good

institutional innovation environment and business environment, provides tax relief for key enterprises, and provides sufficient financial support for R&D enterprises; enterprises should pay attention to the training of professional high-tech talent, to support enterprise innovation and development. At the same time, enterprises can also provide technical support for development by establishing scientific research centers.

### 5.4 Perfecting Regional Coordinated Development of the Three Northeast Provinces

The three northeastern provinces should make use of the advantages of digital economy to promote the revitalization strategy of northeast China according to their own manufacturing development foundation. First of all, the three northeastern provinces should strengthen exchanges and cooperation to promote mutual learning of resource elements, advanced technology and management experience; at the same time, play to their comparative advantages, to achieve coordinated development, and thus promote the transformation and upgrading of manufacturing in the three northeastern provinces.

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