Analysis of the Influencing Factors of High-Tech Service Industry Agglomeration on Manufacturing Upgrading Under Information Technology—Based on Two-Way Fixed Effect Model

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Abstract. With the rapid growth of 5G technology, Industrial Internet and other new generation of the information technology industry, greatly promote the development of high-tech services, thus accelerating the transformation and upgrading of the manufacturing industry. The paper uses panel data from 31 provinces in China from 2008 to 2019 to construct a comprehensive index of manufacturing upgrading by principal component analysis and empirically analyzes how the high-tech services industry agglomeration effects on manufacturing's transformation and upgrading by using a two-way fixed-effect model. The results show that the agglomeration of high-tech service industries has a significant role in promoting the transformation and upgrading of the manufacturing industry, and the level of foreign direct investment, human capital and government participation play a role in promoting the transformation and upgrading of the manufacturing industry, while the level of economic development and fixed asset investment have a restraining effect on the transformation and upgrading of the manufacturing industry.

Keywords: High-Tech Service Industry Agglomeration · Manufacturing Upgrading · Two-Way Fixed Effect Model · Information Technology

1 Introduction

The manufacturing industry occupies a very important position in the national economy and is an important part of measuring a country's comprehensive national strength and economic strength. In recent years, with the development of a new generation of technologies such as cloud computing and Internet of Things, information service industry has been greatly improved. The information service industry is the main body of the modern high-tech service industry. So it will accelerate the high-tech service industry into the next stage. The high permeability, high drive, high multiplication and high innovation of information technology, especially industrial Internet, can promote the integration of

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traditional manufacturing products, prompt the transformation and upgrading of traditional manufacturing industries to intelligent manufacturing industries, and make manufacturing industries climb from the low end of the value chain to the high end. Data gradually becomes a new factor of production, with information and communication industry, Internet, Internet of Things and mobile communication network as infrastructure carriers, reshaping the new form of economic development pattern, while China's manufacturing industry is still dominated by traditional factors of production, and cannot realize transformation and upgrading with the wings of "data". To realize the upgrading and intelligent development of China's manufacturing industry, therefore, it is crucial to explore the factors influencing the transformation and upgrading of the manufacturing industry.

Judging from the existing literature, only some of the research involves the impact of service industry agglomeration on the transformation and upgrading of the manufacturing industry at the national level, and these studies pay less attention to regional heterogeneity and dynamic analysis, this paper will focus on the service industry to the high-tech service industry and analyze the impact of high-tech services industry agglomeration on the transformation and upgrading of the manufacturing industry from multiple angles and at multiple levels. It is hoped that the theoretical research related to the transformation and upgrading of China's manufacturing industry can be enriched, and practical suggestions for increasing the agglomeration of high-tech service industries for the transformation and upgrading of the manufacturing industry are of strong theoretical significance.

2 Literature Review

This paper mainly studies the influencing factors of promoting the manufacturing industry upgrading and the way of industrial upgrading.

2.1 Factors Promoting the Upgrading of the Manufacturing Industry

Domestic and foreign scholars [1, 2, 4] believe that the knowledge-intensive services industry can promote the transformation and upgrading of the manufacturing industry through its innovation ability and knowledge spillover effect through different levels and angles. Minle Lü and other scholars [3] found that the development of knowledge-intensive service industries can effectively promote the upgrading and innovation of high-tech manufacturing, but the regional and industrial gaps are more obvious, and the effect of promotion in the central and eastern regions is significantly better than that in the western region.

2.2 Research on Ways to Promote Industrial Upgrading

Many domestic scholars believe that the knowledge-intensive service industry can promote the upgrading of the manufacturing industry. For example, Xiaoxin Zhang [4] believes that the knowledge-intensive service industry can promote the transformation of the manufacturing industry to the high-end of the value chain and realize the upgrading of the manufacturing industry. Through further analysis,Yan Pei [5] believes that the knowledge-intensive service industry can input manpower and knowledge capital for the manufacturing industry, improve the production efficiency and competitiveness of the manufacturing industry, and thus promote the transformation and upgrading of the manufacturing industry.

3 Model Building and Variable Data Description

3.1 Variable Selection

3.1.1 The Explanatory Variable

The paper uses the principal component analysis method to construct four single indicators of labor productivity, manufacturing profit margin, total asset profit margin and manufacturing added value into a comprehensive index to measure the transformation and upgrading of the manufacturing industry.

The article refers to Yi Liu's 2016 research with labor productivity, manufacturing profit margin, manufacturing added value and total asset rate four indicators to represent the manufacturing transformation. Finally, through the principal component analysis method, the four single indicators of labor productivity (X_1), manufacturing profit margin of the total asset (X_2), profit margin (X_3) and manufacturing added value (X_4) are constructed into comprehensive indicators to measure the transformation and upgrading of the manufacturing industry.

It can be seen from the following table that the eigenvalues of the first and second principal components are 1.95 and 1.01, respectively, both greater than 1, and the contribution rate of the cumulative variance of these two principal components is 74.06%, close to 80%. Therefore, the four indicators selected above can be combined into these two principal components for calculation (Table 1).

Based on the component matrix in the following table and the squared values of the eigenvalues of the two principal components, the calculation result is (Table 2).

$$MIU_{it1} = -0.1143X_1 + 0.4294X_2 + 0.6273X_3 + 0.6396X_4 \tag{1}$$

$$MIU_{it2} = 0.9763X_1 + 0.0932X_2 + 0.1832X_3 - 0.0678X_4 \tag{2}$$

Table 1. Principal component analysis results.

component	eigenvalue	difference	proportion	cumulative
X_1	1.95018	.938018	0.4875	0.4875
X_2	1.01216	.229394	0.2530	0.7406
X_3	.782763	.527858	0.1957	0.9363
X_4	.254905		0.0637	1.0000

Table 2. Component matrix.

variable	Comp1	Comp2
X_1	−0.1143	0.9763
X_2	0.4294	0.0932
X_3	0.6273	0.1832
X_4	0.6396	−0.0678

Table 3. Determining the weights of indicators.

Principal ingredient		MIU_{it1}	MIU_{it2}
Variance Contribution %		48.75	25.31
Coefficients in a linear combination	X_1	−0.1143	0.9763
	X_2	0.4294	0.0932
	X_3	0.6273	0.1832
	X_4	0.6396	−0.0678
Coefficients in a synthetic scoring model	X_1	0.1914	
	X_2	0.2329	
	X_3	0.3522	
	X_4	0.2946	

In summary, the four original indicators can be expressed with the first two principal components, so the variance contribution rate of the two principal components can be used as the weight when calculating, and the result is as follows (Table 3).

In summary, the comprehensive model of the manufacturing industry transformation and upgrading indicators is:

$$MIU_{it} = 0.1914X_1 + 0.2329 + 0.3522X_3 + 0.2946X_4 \tag{3}$$

At the same time, since the sum of the weights of the four indicators in the linear model should be in units of "1", it is necessary to weight the indicator coefficient calculation results of the comprehensive model again and carry out normalization processing, and the results are as follows (Table 4).

The normalized measurement index model of manufacturing transformation and upgrading is:

$$MIU_{it} = 0.1787X_1 + 0.2174 + 0.3288X_3 + 0.2751X_4 \tag{4}$$

Table 4. Indicator normalization.

index	Coefficients in a synthetic scoring model	Metric weights
X_1	0.1914	0.1787
X_2	0.2329	0.2174
X_3	0.3522	0.3288
X_4	0.2946	0.2751

3.1.2 Core Explanatory Variables

Location entropy value has always been used by most scholars to measure the strength of Mashell agglomeration, its data is easy to obtain and has relatively high reliability, this paper selects the location entropy of high-tech service industries in various provinces as the core explanatory variable, with specific reference to Ke Zhang's approach, the calculation formula is: $LQ_{ij} = (S_{ij}/S_j)/(S_i/S)$, which LQ_{ij} indicates the location entropy value, S_{ij} indicates the number of employees in the 'i' industry in the 'j' province, S_j indicates the number of jobs in all industries in 'j' province, S_i represents the number of employees in the national 'i' industry, and 'S' represents the employment of all industries in the country.

3.1.3 Control Variables

Regional Economic Development Level (ed) selects per capital GDP to measure the level of economic development in each region; Fixed Asset Investment Level (fc) uses the amount of per capital fixed-asset investment to measure the level of fixed asset investment; Human capital (hr) selects the number of people educated in higher education; Government participation(Gov) selects the ratio of expenditure in the general budget of local finance to GDP; Foreign Direct Investment (FDI) selects the total investment of foreign enterprises.

3.2 Model Setting

To investigate the impact of high-tech services industry agglomeration on manufacturing upgrading, this paper uses panel data from 31 provinces from 2008 to 2019 to empirically analyze the positive driving effect of high-tech services industry agglomeration on manufacturing upgrading. Considering that the driving process of high-tech services industry agglomeration on the upgrading of the manufacturing industry will also be affected by other important factors, based on the existing theoretical research results and data availability, this paper selects the regional economic development level, fixed asset investment level, human capital, government participation and foreign direct investment as the control variables, and the basic estimation model is set as follows:

$$MIU_{it} = \alpha_0 + \beta_0 + \alpha_1 HA_{it} + \beta_1 ed_{it} + \beta_2 fc_{it} + \beta_3 hr_{it} + \beta_4 gov_{it} + \beta_5 fdi_{it} + \varepsilon_{it} \quad (5)$$

In the formula, subscript ‘i’ represents different provinces and ‘t’ represents time or year, which ‘ε’ is a random perturbation term., α_0, β_0 is the intercept item.

α_1, β respectively represents the estimation coefficient vectors of the core explanatory variables and the control variables. ‘MIU’ is the level of manufacturing upgrading; ‘HA’ is the level of high-tech service industry agglomeration in various provinces, ‘ed’ represents the level of economic development of each province, ‘fc’ represents the level of fixed asset investment in each province, hr represents the level of human capital in each province, ‘gov’ represents the degree of participation of governments, and ‘fdi’ represents the level of foreign investment in each province.

The paper estimates that the sample is 31 provinces (municipalities and autonomous regions) except Hong Kong, Macao and Taiwan, and the statistics are derived from the 2008–2019 China Statistical Yearbook, the Statistical Yearbook of each province (municipality and autonomous region) and the Classification of National Economic Industries (GB/T454-2011).

4 Empirical Estimation and Analysis of Results

4.1 Data Testing and Model Selection

To ensure that the data are stationary and avoid pseudo-regression problems, this paper performed LLC unit root test on 7 variables, and the test results showed that all the sample variables except fdi rejected the null hypothesis of “presence of unit roots” at a significance level of 1%. After the first-order difference in fdi, the null hypothesis of “the existence of a unit root” is rejected.

First, the Wald F tests of the sample data all passed the 1% significance test, indicating that the fixed-effects model was more suitable for the sample data estimation in this paper than the mixed-effects model, and secondly, the p-values of the Lagrange multiplier (LM) test of the sample data were all 0, rejecting the null hypothesis, indicating that the sample data had a more significant random effects feature than the mixed-effects model. For the above two test results, the individual effect characteristics of the sample data were screened using the Hausman test, and according to Table 5, at a confidence level of 1%, the Hausman test of the sample data rejected the null hypothesis, that is, the sample data should be estimated by a two-way fixed effects model.

Table 6 shows the regression results of (1) mixed-regression model (OLS), (2) fixed-effect model (FE-robust), and (3) bidirectional fixed-effect model (FE-TW-DED).

Table 5. Hausman test.

test: H_0: E(X*epsilon $\neq$ 0)
chi2(7) = (b − B)’[(V_b − V_B)^(−1)](b − B)
= 72.22
Prob > chi2 = 0.0000
(V_b − V_B is not positive definite)

Table 6. Panel regression results.

variables	(1) OLS	(2) FE-robust	(3) FE-TW-DED
ha	0.561*** (0.0258)	0.102*** (0.0347)	0.019*** (0.0157)
ed	−0.411*** (0.0563)	−0.426*** (0.0756)	−0.537*** (0.654)
fc	−0.001*** (0.142)	−0.026*** (0.243)	−0.093*** (0.187)
fdi	0.202** (0.0785)	0.213** (0.0658)	0.216** (0.756)
gov	0.103*** (0.156)	0.384*** (0.0845)	0.457*** (0.0541)
hr	0.528*** (0.0566)	0.312*** (0.0723)	0.387*** (0.0344)
_cons	0.119 (0.725)	0.201 (1.074)	0.125 (1.225)
N	372	372	372
R-sq	0.864	0.923	0.942

By analyzing the estimated results of the model (3) in Table 6, it can be seen that:

From Table 6, it can be seen that the result fitting coefficient of the bidirectional fixed-effect model of the model (3) is 0.942, indicating that the overall fitting effect is better; the P-value is less than 0.01, indicating that the significance of the model is significant at the significance level of 1%, and most of variables are significant at the significance level of 1%.

5 Conclusions and Recommendation

From Table 6, it can be seen that there is a significant correlation between the agglomeration of high-tech services industries and the transformation and upgrading of the manufacturing industry, and the correlation is positive, which is significant at the significance level of 1%, indicating that the agglomeration of high-tech services industries is an important influencing factor for the transformation and upgrading of the manufacturing industry.

There is a significant negative driving effect of the economic development level and the level of fixed asset investment on the transformation and upgrading of the manufacturing industry, indicating that the higher level of economic development and fixed asset investment, the more it can inhibit the transformation and upgrading of the manufacturing industry.

FDI passed the 5% significance test, indicating that the level of foreign investment has a significant correlation with the transformation and upgrading of China's manufacturing industry, and the correlation is positive, indicating that China's market technology exchange strategy is effective.

The impact of government participation and human capital level is significant, passing the significance level of 1%, and the coefficient is positive, indicating that there is a positive correlation, which shows that government participation and human capital level will promote the transformation and upgrading of the manufacturing industry.

Through the collation of relevant literature and theories of the agglomeration of high-tech service industries and the transformation and upgrading of manufacturing industries, as well as the empirical analysis results of the samples selected in this paper, the following suggestions are proposed:

First, improve the business environment and further introduce foreign direct investment. By raising the threshold for foreign investment access, improving the quality of foreign investment in China, improving the technological spillover effect brought about by foreign investment, and promoting the manufacturing industry from the lower end of the value chain to the higher end of the position. When introducing more foreign direct investment, optimize the structure of capital investment and encourage the investment in high-end manufacturing to stay.

Secondly, strengthen the government's policy support and guidance. The government can formulate corresponding industry financial subsidy policies and talent introduction policies to reduce the operating pressure of manufacturing enterprises and help enterprises to introduce and stay talents.

Thirdly, increase investment in human capital. The popularization of nine-year compulsory education and higher education is that the number of people educated and the level of education of our government have increased, but the average number of years of education is generally about 9 years, indicating that most people in China only have the level of primary Chinese, low human capital, and lack of high-end talent capital. Therefore, it is necessary to increase investment in higher education, improve the talent training mechanism of colleges and universities, and on this basis, gradually realize the transformation and upgrading of the manufacturing industry through the introduction of talents and skills training.

Fourthly, the use of the Internet to promote the transformation and upgrading of traditional manufacturing industries. To improve the level of manufacturing information, intelligence, service, etc., we should constantly accelerate the industrial scientific research, so that the high-tech service industry such as R&D design and information technology can become the main driving force to promote the optimization and upgrading of industrial structure, and actively guide the transformation and upgrading of manufacturing enterprises.

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