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Analysis on the Influence Factors of the Integration of Manufacturing Industry and Logistics Industry on the Industrial Upgrading of Manufacturing Industry

Yuhui Guo, Lin Su

Shanghai Dianji University, Shanghai, China

Abstract

Manufacturing industry is the main force of innovation-driven high-quality economic development, accelerating the upgrading of traditional manufacturing industry is an inevitable requirement to promote new industrialization and accelerate the construction of manufacturing power. Based on the entropy method and the coupling coordination degree model, this paper analyzes the industrial upgrading of manufacturing industry from the direction of the integrated development of manufacturing industry and logistics industry, and conducts empirical research on the panel data of the integration level of manufacturing industry and logistics industry and the industrial upgrading level of manufacturing industry in 31 provinces and cities in China from 2013 to 2022 (excluding Hong Kong, Macao and Taiwan).The results show that: (1) As a whole, the coupling and coordination degree of the two industries is increasing, but the overall development degree of the manufacturing and logistics industries in various provinces and cities is not balanced, which restricts the benign coupling and collaborative development of the two industries; (2) The level of industrial upgrading of the manufacturing industry in China is on a good upward trend, but there is an obvious imbalance in the level of industrial upgrading of provinces and cities, among which Beijing has the best level of industrial upgrading of the manufacturing industry, and Henan is the worst. (3) Each control variable has different impacts on manufacturing industry upgrading in different regions, and government intervention has different positive and negative impacts in some regions; The degree of openness is significant in East China and Southwest China, and the influence is different. The level of human capital is different in North China, Northeast China and South China. The level of economic development is significantly positive in some regions.

Keywords

Integration of Manufacturing Industry and Logistics Industry; Manufacturing Industry Upgrading; Coupling Coordination Degree Model; "Two Professions".

1. Introduction

The report of the 20th National Congress of the Communist Party of China stressed that the manufacturing industry, as the foundation of the real economy, is an important support for promoting high-quality economic development. Promoting the transformation and upgrading of the traditional manufacturing industry is a strategic choice to proactively adapt to and lead a new round of scientific and technological revolution and industrial transformation, an important measure to improve the resilience and safety of the industrial chain and supply chain, and an inevitable requirement to promote a new type of industrialization and accelerate the construction of a manufacturing power. In February 2019, the National Development and Reform Commission issued the Opinions on Promoting High-quality Development of Logistics to Promote the Formation of a Strong Domestic Market, which clearly stated that it is necessary

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to promote the deep integration of modern logistics industry and manufacturing industry. In order to promote the transformation and upgrading of the manufacturing industry, in 2020, the National Development and Reform Commission and other departments of industry and information technology developed the Implementation Plan for Promoting the Deep Integration and Innovative Development of the Logistics Manufacturing Industry. In March 2021, the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of 2035 Vision Goals proposed to deepen the implementation of the strategy of manufacturing power. In this context, it is of great practical significance to study the impact of integrated development of manufacturing industry and logistics industry on the industrial upgrading of manufacturing industry. On the basis of reviewing relevant literature, this paper uses entropy method and coupling coordination degree model to conduct in-depth analysis on the integrated development level and upgrading level of manufacturing industry and logistics industry in 31 provinces and cities in China. It is found that the integrated development of manufacturing industry and logistics industry in China has regional differences, low level of integration and low level of integration. Lead to regional differences in manufacturing industry upgrading. Therefore, it is of great practical significance to study the integrated development level of manufacturing industry and logistics industry, further explore the influencing factors that affect the coordinated development of the two industries and their impact on the industrial upgrading of manufacturing industry, and put forward corresponding suggestions and countermeasures accordingly.

2. Literature Review

Promoting the deep integration of manufacturing industry and logistics industry is the strategic demand of national economic development. At present, the research on the integration and development of manufacturing industry and logistics industry mainly focuses on the following aspects:

First, research on the development relationship between manufacturing and logistics industry. Jiang and Dong (2015) [1]believe that the study on the linkage between manufacturing and logistics industry should be shifted to the study on the relationship between logistics chain and product supply chain. Chen and Yang Maofu et al. (2014)[2] believe that the realization of the linkage development of logistics industry and manufacturing industry depends on the coordinated linkage development of logistics enterprises and manufacturing enterprises. Zou Xiao and Zhang Ling (2014)[3] believe that the joint development of manufacturing industry and logistics industry does not follow a symbiotic model, and their choice of symbiotic model changes with the development stage where the symbiotic unit is located and the changes of the symbiotic environment. Gan Weihua and Wang Juan (2010)[4] believe that the development of modern logistics industry is an important support for manufacturing technology upgrading and cost reduction. Wei Qi (2011)[5]believes that in the process of the linkage development of manufacturing and logistics industry, logistics enterprises are often in a passive and subordinate position to some extent, so the development of logistics industry should comply with the development needs and industrial layout of manufacturing industry. Manufacturing industry and logistics industry influence and restrict each other. Logistics is the core of manufacturing supply chain management, ensuring the timely supply of manufacturing raw materials, the smooth operation of the production process and the accurate delivery of finished products. By providing efficient and intelligent logistics services, it provides a strong guarantee for the innovative development of the manufacturing industry. The development of the manufacturing industry has also driven the technological innovation and industrial upgrading of the logistics industry to a large extent.

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Second, research on the integration and development of manufacturing and logistics industries. Chen Shengli and Wang Dong (2022)[6] believe that the integrated development level of manufacturing and logistics industry shows a very low and rising trend, and there is a significant spatial difference. Yang Yang and Gao Fan et al. (2023)[7] believe that green technology innovation under the integrated development of the two industries is an important action to achieve sustainable development. Liang Hongyan (2021)[8] believes that in the integration system of the two industries, the promotion effect of the logistics industry on the manufacturing industry is far greater than the driving effect of the manufacturing industry on the logistics industry. Tian Qiang and Liu Yan et al. (2022)[9] believe that the coordinated development level of manufacturing industry and logistics industry in East China showed dynamic fluctuations from 2010 to 2019. Although there were different degrees of improvement, the overall development level was low. Wang Ling and Li Yueqing (2023)[10] believe that the bidirectional copolymerization of logistics industry and manufacturing industry has obvious industry differences. Qin Yan (2022)[11] believes that the scene-oriented innovation of logistics services in manufacturing industry is the inevitable result of further refined division of labor based on the digital economy in socialized large-scale production. Liu Zhiyi and Chen Shuang (2022)[12] believe that the integrated development of the two industries can bring more development carriers and promote the transformation and upgrading of the two industries.

The third is the research on the influencing factors of the integrated development of manufacturing and logistics industries. The increase of human capital and scale of advanced manufacturing industry is conducive to improving the coupling and collaborative development efficiency of logistics industry. The improvement of the scale and technical efficiency of the logistics industry is conducive to promoting the collaborative development with advanced manufacturing[13]. Infrastructure construction, government intervention, development zone construction, informatization level, city size, human capital, and economic development level all have a significant impact on industrial collaborative agglomeration, but the direction and degree of impact are heterogeneous and dynamically adjusted[14]. Government intervention degree and technological innovation ability are not significantly correlated with the integrated development level of the "two industries", while economic development level and urbanization level are significantly positively correlated with the integrated development of the "two industries", while informatization level is significantly negatively correlated with the integrated development of the "two industries"[15]. In terms of promoting the collaborative agglomeration and integrated development of manufacturing industry and logistics industry, it is an important way to reasonably adjust and optimize the average variable cost of logistics enterprises[16]. The input efficiency of manufacturing industry is an important factor affecting the coupling and coordinated development of the two industries[17].

At present, there are few studies on the relationship between the integration of manufacturing industry and logistics industry and the upgrading of manufacturing industry. However, relevant studies have proved from different angles that the integration of the two industries can promote the transformation and upgrading of the manufacturing industry. The synergy of logistics industry and manufacturing industry has a significant positive impact on high-quality economic development[18]. The coordinated development of the two industries plays an important role in promoting the development of the manufacturing industry. Meanwhile, the logistics demand released by the development and expansion of the manufacturing industry will also play an important role in promoting the development of the logistics industry[19]. The development and expansion of logistics clusters will improve the total factor productivity of urban manufacturing industry by improving the specialization level of logistics industry and the degree of collaboration of logistics manufacturing industry[20]. From a nationwide perspective, the coupling coordination degree of the "two industries" has a significant positive

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correlation with the high-quality development of the manufacturing industry[21]. The integrated development of logistics industry and manufacturing industry in China has a positive impact on the upgrading of manufacturing industry, but the impact effect will be different due to the different degree of integration of the two industries in different regions[22].

3. Research Design

3.1. Index System Construction

Table 1. Evaluation index system and index weight of coordination degree between manufacturing industry and logistics industry

subsystem	Primary index	Secondary index	unit	Pointer code	weight
Manufacturing industry	Industrial scale	Gross industrial product	Hundred million yuan	M_1	0.1041
		Number of legal entities in manufacturing industry	a	M_2	0.2220
	Industrial input	Manufacturing fixed asset investment	Hundred million yuan	M_3	0.1628
		Employment in manufacturing	Thousands of people	M_4	0.2278
	Industrial benefit	Gross profit	Hundred million yuan	M_5	0.1447
		Manufacturing value added		M_6	0.1364
		Profit rate of cost expense	%	M_7	0.0022
Logistics industry	Industrial scale	Volume of freight traffic	Ten thousand tons	L_1	0.0986
		Turnover of goods	100 million ton-kilometers	L_2	0.4115
		Number of legal persons in logistics industry	a	L_3	0.1590
	Industrial input	Investment in fixed assets in logistics industry	Hundred million yuan	L_4	0.1037
		Number of employees in the logistics industry	Thousands of people	L_5	0.0818
	Industrial benefit	Added value of logistics industry	Hundred million yuan	L_6	0.1073
		Labor productivity	100 million yuan / 10,000 people	L_7	0.0381

Table 2. Index system of manufacturing industry upgrading

Primary index	Secondary index	Calculation method	unit	Pointer code	weight
efficiency	Effective labor productivity	Manufacturing value added/employment	100 million yuan / 10,000 people	X_1	0.0894
	Effective capital productivity	Manufacturing value added/fixed asset investment	%	X_2	0.4326
benefit	Gross profit	Profits of industrial enterprises above designated size	Hundred million yuan	X_3	0.2228
	Return on total assets	Total profit/Sum of current assets and fixed assets	%	X_4	0.2552

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The research focus of this paper is divided into two parts: one is to measure the integrated development level of manufacturing industry and logistics industry (hereinafter referred to as "the two industries"); the other is to analyze the impact of the integration of the two industries on the industrial upgrading of manufacturing industry. This paper selects the appropriate index system, calculates the integration development level of the two industries based on the system coupling coordination model, and uses the entropy method to measure the industrial upgrading level of the manufacturing industry.

3.2. Construction and Evaluation Criteria of Coupling Coordination Degree Model

Taking the coupling and coordination relationship between the two systems as the research goal, the steps of constructing the evaluation system are as follows:

Step 1: Data standardization.

$$x_{ij}=(\lambda_{ij}-\lambda_{ijmin})/(\lambda_{ijmax}-\lambda_{ijmin}) \quad (1)$$

Among them, $\lambda_{ij}, \lambda_{ijmax}, \lambda_{ijmin}$ represents the value, maximum value and minimum value of system i index j in period t, respectively, Z_{ij} it is the result of standardization of each index.($x_{ij} \in [0,1]$,i=1,2 represents the manufacturing subsystem and the logistics subsystem, respectively)

Step two: entropy weight method weight.

$$u_{it}=\sum_{j=1}^{n}\eta_{ij}x_{itj},\sum_{j=1}^{n}\eta_{ij}=1 \quad (2)$$

Among them, u_{it} represents the comprehensive development level of subsystem i in the t period,η_{ij}indicates the weight corresponding to indicator j of system i.

Step 3: Establish the entropy weight-coupling coordination degree model, as follows:

$$C_t=2*\left[\frac{u_{1t}u_{2t}}{(u_{1t}+u_{2t})^2}\right]^{\frac{1}{2}} \quad (3)$$

Among them,C_t is the coupling degree value of manufacturing industry and logistics industry in the t period,the value can be $C_t \in [0,1]$. C_t the greater the value,the smaller the degree of dispersion between subsystems, the higher the degree of coupling; On the contrary, the coupling degree between subsystems is lower. Considering that the two subsystems may have a high degree of coupling but a low level of development, in order to accurately investigate the interactive development level of the manufacturing industry and the logistics industry, the coupling coordination degree of the system needs to be further obtained, as shown in formula (4) :

$$D_t=(C_t*T_t)^{\frac{1}{2}},T_t=\alpha u_{1t}+\beta u_{2t} \quad (4)$$

Among them,D_t is the coupling coordination degree of manufacturing industry and logistics industry in t period, the value range is $D_t \in [0,1]$.T_t is the comprehensive harmonic index of the two subsystems in the t period, α and β are undetermined coefficients and meet α+β=1. Considering that the flow efficiency is as important as the production efficiency, α=β=0.5 is taken.

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3.3. Calculation and Analysis of the Results of the Integrated Development Level of the Two Industries

After obtaining the standardized data of each indicator and the corresponding weight value, the comprehensive evaluation value of the provinces and cities is obtained, and the results are sorted out to get Table 3. In Table 3, "Change" is the difference between the data of the manufacturing or logistics industry of each province and city in 2022 and 2013. If the value is positive, the industrial development in 2022 is more orderly than that in 2013; otherwise, there is a decline. As can be seen from Table3, the comprehensive evaluation value of provinces and cities in China showed an overall upward trend during 2013-2022. In terms of the change of the comprehensive evaluation value of the manufacturing industry, the largest increment is in Guangdong, which increases from 0.4121 in 2013 to 0.8336 in 2022; In contrast, Liaoning, Jilin and Heilongjiang saw negative growth. In terms of the change of the comprehensive value of the logistics industry, the largest increment is Hainan, which increases from 0.0384 in 2013 to 0.7666 in 2022; All provinces and cities have different degrees of increase, only Tianjin and Xizang have negative growth. The study found that the comprehensive evaluation value of manufacturing and logistics industries in Guangdong, Jiangsu, Zhejiang and Shandong increased significantly during 2013-2022, indicating that the manufacturing and logistics industries in these four provinces have achieved rapid development, and the coordination degree of the two industries may be high. However, there is a large difference in the comprehensive evaluation value of Hainan and Yunnan industries, which also shows that the resource factor endowment is different in each region of our country, and its development speed and development status are different.

According to Table 3, it can be further seen that the difference between the comprehensive evaluation value of the manufacturing industry and the comprehensive evaluation value of the logistics industry in each province and city during 2013-2022 is as follows: In 2013, the comprehensive evaluation value of the logistics industry in most provinces and cities was greater than that of the manufacturing industry, except for Jilin, Jiangsu, Zhejiang, Fujian, Jiangxi, Shandong, Henan, Hubei and Guangdong, which indicated that the development of the manufacturing industry was relatively lagging behind the development of the logistics industry. Since 2020, only six provinces, Zhejiang, Anhui, Fujian, Jiangxi, Hunan and Guangdong, have a comprehensive evaluation value of manufacturing industry greater than that of logistics industry, and the development of logistics industry in other regions is ahead of manufacturing industry. This lead is only a dynamic, short-lived lead, it will depend on many factors, such as the internal and external environment of the industry. On the whole, the development of logistics industry is stronger than the development of manufacturing industry, and the logistics industry occupies a leading position in the process of the collaborative development of the two industries, and the industrial cooperation mainly depends on the driving effect of logistics industry on the manufacturing industry.

Table 3. Comprehensive evaluation of the national manufacturing and logistics industries

	exponent	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	change
Beijing	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.12	0.10	0.04	0.06
	0.12	0.12	0.12	0.12	0.14	0.14	0.14	0.13	0.13	0.13	0.01	0.12
Tianjing	0.09	0.10	0.10	0.10	0.07	0.08	0.07	0.06	0.09	0.09	0.00	0.09
	0.43	0.11	0.11	0.11	0.12	0.12	0.11	0.12	0.13	0.15	-0.28	0.43
Hebei	0.19	0.22	0.23	0.26	0.25	0.27	0.29	0.23	0.28	0.29	0.10	0.19
	0.26	0.26	0.26	0.27	0.31	0.33	0.35	0.36	0.37	0.37	0.12	0.26
Shanxi	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.06	0.12	0.14	0.08	0.06
	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.17	0.20	0.20	0.09	0.11
Nei	0.09	0.10	0.08	0.09	0.07	0.71	0.08	0.06	0.12	0.14	0.05	0.09

ISSN: 2692-7608 DOI: 10.6981/FEM.202410_5(10).0004

menggu	0.18	0.17	0.15	0.16	0.17	0.17	0.17	0.17	0.18	0.19	0.01	0.18
Liao ning	0.18	0.19	0.17	0.12	0.13	0.14	0.14	0.12	0.13	0.14	-0.05	0.18
	0.19	0.21	0.21	0.18	0.19	0.18	0.17	0.17	0.18	0.19	0.00	0.19
Jilin	0.08	0.09	0.10	0.10	0.09	0.08	0.06	0.06	0.07	0.07	-0.01	0.08
	0.07	0.07	0.08	0.08	0.09	0.09	0.08	0.08	0.10	0.10	0.03	0.07
Heilong jiang	0.08	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.07	-0.01	0.08
	0.08	0.09	0.09	0.10	0.11	0.09	0.09	0.09	0.09	0.10	0.02	0.08
Shang hai	0.11	0.13	0.14	0.14	0.15	0.15	0.14	0.15	0.16	0.15	0.04	0.11
	0.14	0.15	0.16	0.17	0.18	0.20	0.21	0.20	0.23	0.23	0.09	0.14
Jiangsu	0.55	0.68	0.72	0.77	0.82	0.82	0.79	0.69	0.79	0.82	0.27	0.55
	0.26	0.29	0.31	0.33	0.38	0.38	0.40	0.41	0.46	0.49	0.23	0.26
Zhejiang	0.35	0.48	0.51	0.54	0.56	0.55	0.57	0.47	0.52	0.54	0.18	0.35
	0.19	0.21	0.24	0.26	0.29	0.31	0.34	0.36	0.39	0.40	0.21	0.19
Anhui	0.11	0.17	0.18	0.20	0.22	0.25	0.26	0.25	0.28	0.30	0.19	0.11
	0.19	0.21	0.20	0.21	0.24	0.27	0.30	0.33	0.35	0.36	0.16	0.19
Fujian	0.15	0.18	0.20	0.22	0.24	0.26	0.30	0.27	0.30	0.31	0.16	0.15
	0.15	0.17	0.20	0.22	0.24	0.24	0.22	0.22	0.26	0.28	0.13	0.15
Jiangxi	0.11	0.14	0.15	0.17	0.18	0.20	0.21	0.21	0.24	0.25	0.14	0.11
	0.11	0.12	0.12	0.13	0.14	0.16	0.17	0.18	0.21	0.23	0.13	0.11
Shan dong	0.39	0.47	0.50	0.55	0.58	0.54	0.48	0.46	0.51	0.53	0.15	0.39
	0.26	0.29	0.31	0.35	0.42	0.43	0.47	0.48	0.54	0.58	0.32	0.26
Henan	0.23	0.28	0.29	0.30	0.32	0.30	0.33	0.32	0.35	0.37	0.14	0.23
	0.18	0.20	0.22	0.23	0.26	0.30	0.32	0.35	0.39	0.42	0.24	0.18
Hubei	0.16	0.20	0.21	0.22	0.23	0.25	0.26	0.23	0.27	0.28	0.13	0.16
	0.15	0.17	0.19	0.21	0.24	0.27	0.29	0.26	0.32	0.34	0.19	0.15
Hunan	0.13	0.15	0.17	0.16	0.17	0.19	0.21	0.23	0.25	0.27	0.14	0.13
	0.16	0.17	0.18	0.20	0.22	0.22	0.21	0.22	0.24	0.27	0.11	0.16
Guang dong	0.41	0.49	0.53	0.58	0.65	0.66	0.72	0.76	0.82	0.83	0.42	0.41
	0.34	0.36	0.37	0.40	0.46	0.47	0.50	0.51	0.55	0.56	0.23	0.34
Guangxi	0.07	0.09	0.10	0.10	0.11	0.11	0.12	0.11	0.14	0.15	0.08	0.07
	0.11	0.13	0.14	0.16	0.17	0.18	0.19	0.21	0.26	0.28	0.17	0.11
Hainan	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.07	0.77	0.73	0.04
Chong qing	0.07	0.09	0.10	0.12	0.12	0.12	0.12	0.12	0.14	0.14	0.07	0.07
	0.09	0.11	0.12	0.13	0.15	0.16	0.16	0.17	0.19	0.20	0.10	0.09
Sichuan	0.14	0.16	0.16	0.16	0.17	0.17	0.19	0.21	0.24	0.26	0.11	0.14
	0.16	0.18	0.19	0.22	0.25	0.27	0.27	0.28	0.29	0.33	0.17	0.16
Guizhou	0.04	0.05	0.05	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.06	0.04
	0.12	0.13	0.15	0.16	0.18	0.17	0.14	0.15	0.15	0.17	0.05	0.12
Yunnan	0.05	0.06	0.06	0.06	0.07	0.08	0.09	0.08	0.09	0.10	0.05	0.05
	0.07	0.09	0.09	0.12	0.15	0.19	0.23	0.24	0.26	0.27	0.19	0.07
Xizang	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
	0.02	0.02	0.02	0.03	0.03	0.02	0.01	0.02	0.01	0.01	-0.01	0.02
Shanxi	0.09	0.10	0.09	0.10	0.11	0.12	0.13	0.13	0.16	0.19	0.09	0.09
	0.10	0.12	0.13	0.14	0.15	0.17	0.17	0.18	0.18	0.20	0.10	0.10
Gansu	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.02	0.03
	0.05	0.06	0.06	0.06	0.06	0.07	0.08	0.08	0.09	0.10	0.05	0.05
Qinghai	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.01
	0.01	0.02	0.02	0.03	0.03	0.03	0.02	0.03	0.03	0.04	0.02	0.01
Ningxia	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.01	0.01
	0.05	0.05	0.06	0.06	0.06	0.05	0.05	0.05	0.06	0.06	0.02	0.05
Xinjiang	0.04	0.05	0.04	0.04	0.05	0.05	0.06	0.05	0.08	0.09	0.05	0.04
	0.07	0.08	0.09	0.09	0.14	0.13	0.13	0.11	0.12	0.14	0.08	0.07

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In order to further explore the coupling coordination degree between the manufacturing industry and the logistics industry, 31 provinces and cities were divided into seven geographic regions according to comprehensive geography: North China, East China, Central China, South China, Southwest, Northeast and Northwest, and the regional differences in the integrated development of the two industries were directly explained, so as to formulate regional development policies according to local conditions. Based on the coupling coordination model, the coordinated development level of manufacturing industry and logistics industry in 31 provinces and cities in China during 2013-2022 is calculated.

Table 4. Coupling coordination degree of manufacturing industry and logistics industry in each province of China

region	province	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Mean value
North China	Beijing	0.10	0.48	0.48	0.56	0.73	0.72	0.74	0.61	0.92	0.73	0.61
	Tianjing	0.91	0.31	0.35	0.41	0.30	0.31	0.26	0.15	0.47	0.56	0.40
	Hebei	0.10	0.10	0.37	0.56	0.72	0.84	0.94	0.75	0.95	0.98	0.66
	Shanxi	0.14	0.26	0.15	0.33	0.30	0.59	0.68	0.47	0.92	1.00	0.48
	Nei menggu	0.44	0.42	0.15	0.34	0.28	0.78	0.36	0.24	0.52	0.60	0.41
Northeast region	Liao ning	0.77	1.00	0.90	0.21	0.53	0.56	0.32	0.16	0.47	0.57	0.55
	Jilin	0.28	0.63	0.72	0.86	0.89	0.79	0.51	0.26	0.71	0.69	0.63
	Heilong jiang	0.32	0.65	0.40	0.37	0.70	0.67	0.44	0.22	0.56	0.83	0.52
East China	Shang hai	0.10	0.50	0.60	0.67	0.78	0.86	0.84	0.86	0.99	0.96	0.71
	Jiangsu	0.10	0.51	0.61	0.72	0.84	0.85	0.85	0.76	0.93	1.00	0.72
	Zhejiang	0.10	0.49	0.62	0.71	0.81	0.84	0.91	0.80	0.93	0.96	0.72
	Anhui	0.10	0.45	0.35	0.51	0.63	0.77	0.86	0.87	0.95	1.00	0.65
	Fujian	0.10	0.44	0.59	0.70	0.81	0.84	0.85	0.80	0.94	1.00	0.71
	Jiangxi	0.10	0.40	0.44	0.55	0.63	0.71	0.76	0.80	0.92	1.00	0.63
	Shan dong	0.10	0.43	0.56	0.69	0.83	0.81	0.76	0.72	0.87	0.93	0.67
Central China	Henan	0.10	0.42	0.51	0.58	0.69	0.71	0.81	0.82	0.92	1.00	0.66
	Hubei	0.10	0.45	0.54	0.63	0.70	0.81	0.87	0.75	0.94	1.00	0.68
	Hunan	0.10	0.37	0.47	0.53	0.63	0.68	0.71	0.79	0.90	1.00	0.62
South China	Guang dong	0.10	0.38	0.48	0.59	0.75	0.76	0.85	0.89	0.98	1.00	0.68
	Guangxi	0.10	0.39	0.48	0.56	0.63	0.67	0.71	0.74	0.92	1.00	0.62
	Hainan	0.11	0.19	0.16	0.18	0.27	0.29	0.30	0.30	0.49	0.99	0.33
Southwest China	Chong qing	0.10	0.44	0.57	0.69	0.77	0.80	0.83	0.86	0.98	1.00	0.70
	Sichuan	0.10	0.42	0.42	0.53	0.60	0.65	0.73	0.81	0.90	1.00	0.62
	Guizhou	0.10	0.50	0.61	0.74	0.88	0.84	0.72	0.76	0.82	0.93	0.69
	Yunnan	0.10	0.33	0.38	0.47	0.64	0.76	0.88	0.87	0.95	1.00	0.64
	Xizang	0.25	0.56	0.50	0.75	0.87	0.77	0.67	0.70	0.62	0.32	0.60
Northwest China	Shanxi	0.10	0.35	0.25	0.39	0.59	0.68	0.72	0.74	0.88	1.00	0.57
	Gansu	0.13	0.46	0.20	0.44	0.41	0.52	0.61	0.60	0.85	1.00	0.52
	Qinghai	0.16	0.39	0.32	0.44	0.57	0.57	0.26	0.42	0.72	1.00	0.49
	Ningxia	0.10	0.43	0.53	0.71	0.66	0.59	0.55	0.66	0.89	1.00	0.61
	Xinjiang	0.16	0.37	0.23	0.33	0.65	0.67	0.71	0.58	0.85	1.00	0.56

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From the perspective of the coordination degree of the two industries, the coupling coordination development level of the two industries in 31 provinces and cities shows an upward trend during 2013-2022 under the condition of high coupling degree. The region with the highest average coupling coordination degree is East China, with an average value of 0.686, which belongs to the primary coordination. The second is Central China and Southwest China, where the mean coupling coordination degree of the two industries is 0.650 and 0.649, respectively, belonging to the primary coordination; Then Northeast, Northwest, South China and North China, the corresponding mean coupling coordination degrees are 0.566, 0.549, 0.540 and 0.512 respectively, all belonging to the reluctant coordination in the transition interval. On the whole, the manufacturing and logistics industries have maintained a relatively stable development trend in their respective development processes, and under the coupling effect between each other, the effect of collaborative development is also gradually strengthening. However, although on the whole, the degree of coupling and coordination between manufacturing and logistics is constantly improving, the overall development degree of logistics and manufacturing in various provinces and cities is not balanced, which restricts the benign coupling and collaborative development between the two.

From the perspective of the coupling coordination types of the two industries, the coupling coordination level of each province and city has generally increased, and the overall coordination has improved from the initial serious imbalance to high-quality coordination. The industrial collaborative development in North China was better than that in East China, Central China, South China, Southwest and Northwest China in the early stage, and exceeded that in the later stage, and the degree of collaborative development of the two was significantly improved, while the coupling coordination degree of the two industries in Northeast China was the most unstable, and the coupling coordination degree of the two industries showed a significant decline from 2018 to 2022. It can be found that the industrial development in East China, Central China, South China and Northwest China is rapid, and the degree of coupling and coordination between the two industries has continuously increased in the past 10 years. On the whole, the manufacturing and logistics industries have achieved their own stable development, and through mutual coupling, the effect of collaborative development has gradually increased. However, it is worth noting that although the degree of coupling and coordination between manufacturing industry and logistics industry in China is on the rise steadily on the whole, there is still an imbalance in the comprehensive development level of logistics industry and manufacturing industry in different provinces, which hinders the further benign development of coupling and coordination between the two industries.

3.4. Calculation and Analysis of Manufacturing Industry Upgrading Results

Based on the panel data of 31 provinces from 2013 to 2022, the entropy method is used to measure the comprehensive value of the industrial upgrading level of the manufacturing industry. The research shows that: (1) The industrial upgrading level of the manufacturing industry in China is on a good upward trend, but there is an obvious imbalance in the industrial upgrading level of provinces and cities, among which Beijing's industrial upgrading level is the best and Henan's is the worst. (2) The upgrading level of manufacturing industry in most provinces showed an upward trend from 2013 to 2022, but there were fluctuations in some provinces. For example, Beijing's value continued to increase in most years, while Tianjin's value declined in some years. (3) There are differences in the level of manufacturing upgrading across regions. Jiangsu, Shandong and other provinces in East China have relatively high values in some years; the values of Guizhou and Yunnan provinces in Southwest China are relatively low. (3) The development trend of the upgrading level of manufacturing industry in Liaoning, Jilin and Heilongjiang in Northeast China is different. In some years, Heilongjiang has a

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relatively obvious growth. (4) In general, the upgrading level of China's manufacturing industry has been increasing over time, but the development of different regions is unbalanced.

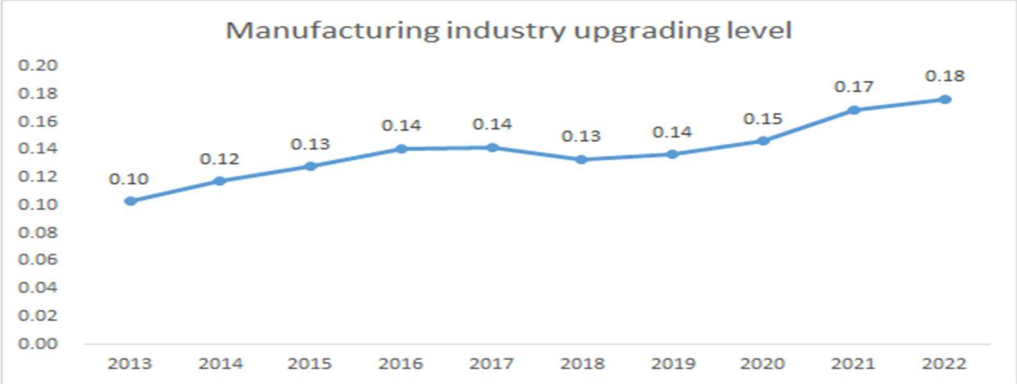

Figure 1. Level of China's manufacturing industry upgrading from 2013 to 2022

4. Empirical Analysis

4.1. Model Design

In this paper, the fixed effect model (FE) and random effect model (RE) of panel data are used to analyze the effects of the integration of the two industries on the industrial upgrading of the manufacturing industry. According to the study of Song Lin et al.[23], the econometric model is constructed:

$$upgrade_{it} = \alpha + \beta_1 D_{it} + \beta_2 gov_{it} + \beta_3 open_{it} + \beta_4 edu_{it} + \beta_5 pgdp_{it} + \varepsilon_{it} \quad (5)$$

Where, it represents the index value of the i province (city) in the t year, is the explained variable in the econometric model, represents the level of manufacturing industry upgrading, is the constant term, is the explanatory variable, represents the level of integration and development of the two industries, is the coupling coordination degree of the two industries, that is, the regression coefficient of the integration and development level of the two industries. ,, and are regression coefficients of government involvement degree (gov), openness degree (open), human capital level (edu) and economic development level (pgdp), respectively, and are random disturbance terms.

4.2. Variable Selection and Data Source

As for the selection of control variables: (1) Government involvement degree (gov), the ratio of state-owned industry to the total output value of manufacturing industry is used to evaluate, reflecting the relative position of state-owned economy in the manufacturing industry, and further revealing the potential impact of market-oriented process and government policies on industrial upgrading. (2) The degree of openness (open), using the ratio of total import and export to GDP to evaluate the degree of correlation between the industry and the external market, showing the degree of dependence of the industry on the international market and its close connection with the global economic system. (3) Human capital level (edu), measured by the proportion of scientific and technological activity personnel to the total number of industry employees, shows the human input of an industry in scientific and technological innovation and research and development, reflecting the potential ability of an industry to achieve industrial upgrading and sustainable development. (4) Economic development level (pgdp), using per capita GDP as the index to quantify, when a region's economic prosperity reaches a higher level,

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it provides a more favorable basic condition for the transformation and upgrading of the manufacturing industry and high-end development.

This paper takes 31 provinces and cities as the research object. In the process of calculating the integrated development of manufacturing industry and logistics industry and its impact on the upgrading of manufacturing industry, in order to ensure the consistency of statistical caliber, the relevant data in this paper are derived from China Statistical Yearbook, China Industrial Statistics Yearbook, statistical Yearbook of provinces and cities over the years, and statistical Bulletin of National Economic and Social Development of the National Bureau of Statistics. The time domain of the study was determined to be 2013-2022. In view of the fact that there is no separate statistical category for the logistics industry, and the transportation, warehousing and postal industries account for more than 90% of the logistics industry, this paper uses the index data of the transportation, warehousing and postal industries to represent the logistics industry approximately. The output value of the manufacturing industry contributes more than 85% to the industry, so the missing manufacturing data in this paper is replaced by the industrial industry.

4.3. Influence and Effect of Coupling Coordination Degree of Two Industries on Industrial Upgrading of Manufacturing Industry

The fixed effects and random effects of panel data of 31 provinces and cities from 2013 to 2022 were empirically analyzed, and the regression results were shown in Table 5. The degree of coupling coordination between explanatory variables and industries D_{it} and the explained variable manufacturing industry upgrading level $upgrade_{it}$ both are positively correlated at the significant level of 1%, 0.053 and 0.052, respectively, indicating that each increase of 1 unit in the coupling coordination degree of the two industries will increase the industrial upgrading level of the manufacturing industry by 0.5 units, that is, the improvement of the coupling coordination degree of the two industries will significantly improve the industrial upgrading of the manufacturing industry.

Table 5. Regression results of influencing factors of national manufacturing industry upgrading

variable	Fixed effect (FE) upgrade	Random effect (RE) upgrade
D_{it}	0.053*** (0.010)	0.052*** (0.009)
gov	-0.052 (0.065)	-0.022 (0.043)
open	0.028 (0.017)	0.028* (0.016)
edu	0.009 (0.012)	0.010 (0.012)
pgdp	0.000*** (0.000)	0.000*** (0.000)
cons	0.081** (0.033)	0.064*** (0.024)

Note:*, **, *** represent separately p<0.1, p<0.05, p<0.01, values in brackets are standard errors.

As can be seen from Table 5, the coefficient of government involvement (gov) is negative under both models and is not significant, indicating that the government involvement has no significant effect on the industrial upgrading of the manufacturing industry. The coefficient of

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openness is positive under both models, but is not significant in the fixed-effect model, while 10% is significant in the random effect model. This may be because the higher degree of openness leads to the intensification of competition among enterprises. In order to have a greater competitive advantage in the international market, enterprises increase operating costs to promote industrial development and upgrading. Human capital level (edu) coefficient is positive under both models, but neither is significant, indicating that human capital level has no obvious effect on the transformation of manufacturing industry. The economic development level (pgdp) coefficient is positive at the significant level of 1%, indicating that the economic development level has a positive impact on the industrial upgrading of the manufacturing industry. The environmental regulation degree (er) coefficient is negative under both models and is not significant, indicating that the environmental regulation degree has no obvious effect on the industrial upgrading of manufacturing industry.

After the fixed effects and random effects model regression analysis of the national panel data from 2013 to 2022, the panel data of the seven regions in the country were further analyzed by regression analysis and Hausman test was conducted. The results are shown in Table 6.

Table 6. Regression results of influencing factors of manufacturing industry upgrading in seven regions of China

variable	All over China	North China	Northeast region	East China	Central China	South China	Southwest China	Northwest China
Regression model	FE	FE	FE	FE	FE	FE	FE	FE
D_{it}	0.053*** (0.010)	0.016 (0.017)	0.010 (0.018)	0.034* (0.018)	-0.023 (0.020)	0.039 (0.027)	0.199*** (0.041)	0.010 (0.019)
gov	-0.052 (0.065)	-0.315** (0.127)	-0.343*** (0.106)	-0.274** (0.127)	-0.386*** (0.073)	-0.027 (0.117)	0.575* (0.294)	0.062 (0.102)
open	0.028 (0.017)	0.014 (0.014)	-0.038 (0.059)	-0.135* (0.076)	-0.050 (0.063)	-0.122 (0.112)	0.460** (0.220)	0.113 (0.067)
edu	0.009 (0.012)	-0.312*** (0.091)	0.323*** (0.077)	0.092 (0.105)	-0.005 (0.009)	-0.298* (0.152)	0.153 (0.139)	-0.001 (0.007)
pgdp	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000*** (0.000)	-0.000 (0.000)	0.000*** (0.000)
cons	0.081** (0.033)	0.102 (0.068)	0.185** (0.081)	0.188*** (0.042)	0.196*** (0.029)	0.017 (0.041)	-0.302 (0.186)	-0.046 (0.073)

Note:*, **, *** represent separately p<0.1, p<0.05, p<0.01, values in brackets are standard errors.

As can be seen from Table 6, the coefficient of the integrated development level of the two industries of the explanatory variables is positive except for central China, in which the southwest region is significant at the significance level of 1%, and the east China region is significant at the significance level of 10%, while the influence of the integrated development level of the two industries in North China, Northeast China, Central China, South China and Northwest China is not significant. The results show that there are regional differences in the effect of the integrated development level of the two industries on the industrial upgrading of the manufacturing industry.

From the effect of each control variable on the industrial upgrading of the manufacturing industry, the effect of government involvement (Gov) on the industrial upgrading of the manufacturing industry is more significant in North China, Northeast China, East China, Central

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China and Southwest China. The influence of GOV in Northeast and central China is negatively correlated at the significance level of 1%, and the influence of Gov in North and East China is negatively correlated at the significance level of 5%. The effect in southwest China was positively correlated at a significance level of 10%. The reason may be that the government intervention in North China, Northeast China, East China and Central China has distorted the resource allocation of the manufacturing industry to a great extent, and has a restraining effect on the industrial upgrading of the manufacturing industry. The government of the southwest region intervened to guide and support the development of the local manufacturing industry and promoted the upgrading of the manufacturing industry. The influence of the degree of openness on the industrial upgrading of the manufacturing industry is more significant in East China and Southwest China. The influence in East China is negatively correlated at the significance level of 10%, and the influence in Southwest China is positively correlated at the significance level of 5%, but the influence in the other five regions is not significant. The reason may be that the economy of East China is developed, the increase in the degree of openness may lead to the intensification of international competition, forcing the local manufacturing industry to accelerate the transformation and upgrading, but it may also have an impact on the existing traditional manufacturing industry, thus showing a negative impact in the short term. The southwest region is relatively weak in economic development, and the increase in openness may bring more foreign investment, technology and market, which will have a positive impact on the upgrading of local manufacturing industry, so it shows a positive correlation. The influence of human capital level (edu) on manufacturing industry upgrading is relatively significant in North China, Northeast China and South China, where it is negative at the significance level of 1% and 10%, and positive at the significance level of 1% in Northeast China, and the other four regions are not significant. This indicates that there are significant differences in economic development stage and human capital accumulation in different regions, which leads to different directions and significance of the influence of human capital on the industrial upgrading of manufacturing industry. North and South China are rich in educational resources and have a high penetration rate of higher education, but this may lead to excess human capital, especially structural unemployment or employment quality problems among highly educated people. The manufacturing industry may not be able to absorb a high level of human capital, resulting in a high level of education can not effectively promote the upgrading of the manufacturing industry, but is negatively correlated; In recent years, the traditional manufacturing industry in Northeast China is dominated by heavy industry, and the pressure of industrial upgrading and structural adjustment is relatively large. The high level of human capital plays a key role in technological transformation, management upgrading and innovation-driven, thus promoting the upgrading of the manufacturing industry, showing a positive correlation. The influence of economic development level (pgdp) on manufacturing industry upgrading is positive at 1% significance level in North China, Central China, South China and Northwest China, but not significant in Northeast China, East China and Southwest China. This shows that in North China, Central China, South China and Northwest China, a higher level of economic development may mean a higher level of capital accumulation and technology introduction, and high-quality resources will help promote the upgrading of the manufacturing industry and improve production technology and efficiency. For example, the high level of economic development in North and South China has promoted technology introduction and capital investment, providing impetus for the upgrading of the manufacturing industry. In Northeast China, East China and Southwest China, although the level of economic development may be higher, the bottleneck problems of manufacturing development, such as aging, rising labor costs, and resource depletion, may limit the positive impact of economic development on manufacturing upgrading. While the northeast has traditionally relied on heavy industry,

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economic development may reflect more the continuation of traditional industries than the upgrading of manufacturing.

5. Conclusion and Suggestions

Based on the entropy method and the coupling coordination degree model, this paper calculates the integrated development level of manufacturing industry and logistics industry and the industrial upgrading level of manufacturing industry in 31 provinces and cities in China. The fixed effect and random effect models are used to empirically analyze the regional differences between the integrated development of the two industries and the industrial upgrading of manufacturing industry. From the perspective of industrial integration, this paper analyzes the influence of the integrated development of manufacturing and logistics industries on the industrial upgrading of manufacturing industry. The results show that: (1) On the whole, the coupling and coordination degree of the two industries is increasing, but the overall development degree of the manufacturing and logistics industries in various provinces and cities is not balanced, which restricts the benign coupling and collaborative development of the two industries; (2) The level of industrial upgrading of the manufacturing industry in China is on a good upward trend, but there is an obvious imbalance in the level of industrial upgrading of provinces and cities, among which Beijing has the best level of industrial upgrading of the manufacturing industry, and Henan is the worst.(3) Each control variable has different impacts on manufacturing industry upgrading in different regions, and government intervention has different positive and negative impacts in some regions; The degree of openness is significant in East China and Southwest China, and the influence is different. The level of human capital is different in North China, Northeast China and South China. The level of economic development is significantly positive in some regions.

According to the research results, the following countermeasures and suggestions are put forward: First, strengthen regional coordinated development and formulate targeted regional development policies. In North, Northeast, East and central China, the government can reduce unnecessary intervention, stimulate market vitality, and let the market mechanism play a decisive role in resource allocation. At the same time, the government should strengthen market supervision and regulation to ensure fair competition and healthy development of the market. In southwest China, the government can provide more financial support and technical assistance, strengthen guidance and support for the development of local manufacturing industry, and promote the upgrading of manufacturing industry. Second, we need to foster a sound investment environment and increase openness. East China should focus on encouraging enterprises to increase investment in research and development, improve the ability of independent innovation, and lead industrial upgrading with technological innovation, while Southwest China should strengthen infrastructure construction, cultivate advantageous industries, and strengthen cooperation with developed regions such as East China. Third, we need to strengthen macro-control and balance supply and demand. Formulate relevant policies to encourage the flow of talents to the places where they are needed, such as giving certain preferential policies to those employed in remote areas and economically underdeveloped areas. Fourth, promote the deep integration of manufacturing and logistics, and formulate development strategies according to local conditions. For different regions, the government should take targeted measures to maximize the positive impact of the integration of logistics industry and manufacturing industry on manufacturing upgrading. For the regions with a relatively mature industrial base and complete industrial chain, the government should focus on consolidating the industrial base and optimizing the industrial development environment by strengthening macro-control. In Southwest China, where the economy is less developed, the industrial base is weak and the industrial chain is not perfect, attention should be paid to

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activating the endogenous driving force of the integration of logistics industry and manufacturing industry, and enterprises should be encouraged to actively explore the innovative mode of the integration of the two industries.

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