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Regional Logistics Industry High-Quality Development Level Measurement, Dynamic Evolution, and Its Impact Path on Industrial Structure Optimization: Finding from China

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Abstract: This paper measures the high-quality development level of China's regional logistics using the comprehensive evaluation method of entropy right TOPSIS. It was found that the high-quality development level of the logistics industry in most provinces of China was effectively improved during the sample observation period. Secondly, the dynamic evolution process and correlation degree are analyzed through kernel-density estimation and the grey correlation-degree method. This study reveals that upgrading the industrial structure is closely correlated with the high-quality growth of regional logistics in China. The overall sample level has a favorable promoting influence and regional variability. Finally, the panel threshold model is constructed to analyze the influence mechanism. The improvement of the industrial structure is impacted by the high-quality growth of the logistics industry, which has the threshold effect of foreign direct investment (FDI).

Keywords: high-quality development; regional logistics industry; industrial structure upgrade; threshold effect; influence effect

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1. Introduction

The logistics industry has achieved high-quality growth and injected new momentum into global economic development as an essential component of real economy development. The logistics industry in China is a large one and is transitioning to high-quality development [1]. However, its traditional development mode is an extensive-growth mode based on the expansion of factor scales. As a result, the role of this low-quality development mode in upgrading the industrial structure is increasingly weak, and this low-quality development mode cannot be sustained. Currently, the logistics industry's advanced storage, transportation, and distribution technologies allow natural resources, social resources, social products, and materials to be allocated reasonably and efficiently to different industries. Therefore, clarifying the impact path for the high-quality development of China's logistics industry to promote the upgrading of the industrial structure can not only facilitate deeper integration between industries but also contribute to promoting new kinetic energy. As a result, industrial technology and structure will be upgraded and innovation abilities will be improved, which is of great reference significance for the vast number of global countries worldwide.

By sorting out relevant literature, it is found that the existing research mainly focuses on the following three aspects:

First are the measurement methods of the high-quality development of the logistics industry. Yan et al. and Zhu constructed a comprehensive evaluation index system from different perspectives to comprehensively evaluate the level in different Chinese regions [2,3]. Yan et al. found significant geographical variations in the growth of the logistics industry in China. Combining the new development concept of "innovation, coordination, green, openness, and sharing," Huang et al. designed a high-quality development-evaluation system for logistics enterprises [4] and Gan et al. analyzed the evolution characteristics

of efficient and high-quality development of green logistics in Jiangxi Province, China [5]. Zhou et al. explored the space–time coupling and influencing factors of regional logistics and regional economy under high-quality development [6].

Second is the investigation of the connection between the growth of the logistics industry and the modernization of the industrial structure. In terms of the correlation between the two, some scholars have found a long-term and stable relationship [7] and others believe that there is a dynamic unbalanced relationship between the development level of the logistics industry and the industrial structure [8]. According to Gao, the industry's quick development has sped up industrial structure optimization and alterations [9]. Shevchenko et al. used the historical analysis method combined with the theory of new structural economics. They found that the development of intelligent logistics and the upgrading of the industrial structure has the characteristics of co-evolution [10]. Liu and Li further constructed a coupling coordination degree model to test the effect mechanism between the two and found that the coupling interaction effect between the two was obvious [11].

Finally, in the research on the relationship between FDI and the development of the logistics industry, Wang believed that the increase of high-quality FDI in the logistics industry could improve China's industrial structure [12]. According to Saidi et al., the development of FDI "attractiveness" is influenced by the infrastructure for transportation and logistics [13]. In exploring the mechanism of action, Feng and Liang found that only when the regional FDI value exceeds the threshold value will the development of the logistics industry significantly promote the growth of the local economy [14]. Wang analyzed the impact mechanism of FDI on the logistics industry in the Beibu Gulf Economic Zone and found that there is a long-term stable equilibrium relationship between the growth of FDI in the logistics industry in the Beibu Gulf Economic Zone and the increase in logistics-output value [15].

By reorganizing and systematically summarizing the results related to this research, it can be found that the existing research findings have laid a theoretical foundation for the research, which has specific reference significance. However, the existing research still has some deficiencies regarding research perspectives and methods. First, in the measurement of high-quality development, the indicators designed by the existing measurement do not cover the indicator system at the level of regional economic development, which makes the research results one-sided to a certain extent. Second, a variety of samples and viewpoints have been used by academics to explore the connection between the growth of the logistics industry and the industrial structure. However, these studies mostly start from a holistic perspective and rarely research Chinese samples from the perspective of regional differences, which cannot effectively reflect the differences. Due to the obvious non-equilibrium in China's regional economy, the development of the derivative-logistics industry is also non-equilibrium. If the analysis is not carried out from a regional perspective, it will undermine the impact of policy execution and is not favorable to creating differentiated regional policies. Finally, the existing research mainly discusses the direct impact of FDI on the development of the logistics industry and the regulatory role of FDI as a threshold value. However, the positive spillover effect exerted by FDI has a nonlinear effect. The regional differences are significant, which will further affect the pattern change of high-quality regional economic development [16,17]. When it comes to the high-quality growth of the logistics industry, would the adjustment impact of the quality and scale of FDI introduced at various times have a non-linear influence on the upgrading of the industrial structure? Existing research has not been able to provide an apparent response to this. Therefore, based on the existing research, this paper expands the gaps in the current study. It not only makes up for the existing research gaps but also deeply analyzes the effect and mechanism of the high-quality development of the logistics industry on the upgrading of the industrial structure, which can straighten out the development path and build a high-quality development plan in the future.

2. Dynamic Evolution and Correlation Degree of High-Quality Regional Logistics Industry Development and Industrial Structure Upgrading

2.1. Measurement and Dynamic Evolution of the High-Quality Development of the Regional Logistics Industry

2.1.1. Construct the Measurement Indicators

To further examine the derivative features of the logistics industry and build an assessment index system for the high-quality growth of the regional logistics industry, this study draws inspiration from the Chinese government's five development principles (see Table 1). Research data used in this paper were drawn primarily from the "China Statistical Yearbook", "China Statistical Bulletin", "China Energy Statistical Yearbook", and "China Environmental Statistical Yearbook", among others.

Table 1. Evaluation index system of high-quality development level of regional logistics industry.

Primary Indicators	Secondary Indicators	Unit of Measurement
The level of innovation and development of the logistics industry	R&D funding (X_1)	RMB 100 million
	Number of employees in the logistics industry (X_2)	10,000 people
	Number of patent inventions granted (X_3)	Item
The level of coordinated development of the logistics industry	Value added of the logistics industry as a percentage of GDP (X_4)	%
	Proportion of the output value of the logistics industry in the tertiary sector (X_5)	%
The level of green development of the logistics industry	Logistics industry energy consumption (X_6)	Million tons
	Urban-greening coverage (X_7)	%
	Postal mileage (X_8)	10,000 km
The level of shared development of the logistics industry	Fixed Internet users (X_9)	10,000 households
	Road-car ownership (X_{10})	Million units
	Railroad and road mileage (X_{11})	Kilometers
The level of open development of the logistics industry	Import and export investment (X_{12})	Billion
	Amount of foreign direct investment (X_{13})	Billion
	Regional GDP (X_{14})	RMB 100 million
Regional economic development level	The level of consumption of the population (X_{15})	RMB
	GDP growth rate (X_{16})	%
	Retail sales of social consumer goods (X_{17})	RMB 100 million

2.1.2. Measurement Method

Combining the study goals and data features of this work with the literature review, the entropy-weight TOPSIS method was used in this research.

(1) Dimensionless standardization of each index:

$$u_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \tag{1}$$

$$u_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)} \tag{2}$$

(2) Calculate the index weight w_{ij}

First, calculate the information entropy of each index x_j:

$$e_j = -\frac{1}{\ln n}\sum_{i=1}^{m} p_{ij} \ln p_{ij}, p_{ij} = x_{ij} / \sqrt{\sum_{i=1}^{n} X_{ij}^2} \tag{3}$$

Then, calculate the redundancy to measure the difference between each indicator. Finally, calculate the index weight w_{ij}

$$w_j = d_{ij} / \sum_{i=1}^{n} d_{ij}, d_j = 1 - e_j \tag{4}$$

(3) Use normalization matrix to perform weighted normative decision-matrix transformation. Positive and negative ideal solutions are calculated.

$$Z = (z_{ij}) = w_j p_{ij} \tag{5}$$

Define the maximum value:

$$Z_j^+ = (z_1^+, z_2^+, \ldots, z_n^+) = \{\max(z_{11}, z_{21}, \ldots, z_{n1}), \max(z_{12}, z_{22}, \ldots, z_{n2}), \ldots, \max(z_{1h}, z_{2h}, \ldots, z_{nh})\} \tag{6}$$

Define the minimum value:

$$Z_j^- = (z_1^-, z_2^-, \ldots, z_n^-) = \{\min(z_{11}, z_{21}, \ldots, z_{n1}), \min(z_{12}, z_{22}, \ldots, z_{n2}), \ldots, \min(z_{1h}, z_{2h}, \ldots, z_{nh})\} \tag{7}$$

(4) Calculate the distance between the positive and the negative ideal solution.

$$D_j^+ = \sqrt{\sum_{j=1}^{h} (z_{ij} - Z_j^+)^2}, i \in [1, n] \tag{8}$$

$$D_j^- = \sqrt{\sum_{j=1}^{h} (z_{ij} - Z_j^-)^2}, i \in [1, n] \tag{9}$$

(5) Calculate the score of the evaluation object:

$$C_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{10}$$

Obviously $0 \leq C_i \leq 1$ and the bigger the better.

2.1.3. Analysis of the Measure Results

Through the application of the entropy-weight TOPSIS method and the use of MATLAB software for numerical analysis, this paper examined the high-quality growth level in the regional logistics industry in China's different provinces (autonomous regions and municipalities) between 2013 and 2020. As shown in Table 2, measurement results were obtained.

Table 2. Measurement results of the high-quality development level of China's regional logistics industry from 2013 to 2020.

Province	2013	2014	2015	2016	2017	2018	2019	2020
Beijing	0.507	0.520	0.503	0.492	0.490	0.494	0.430	0.417
Shanghai	0.425	0.444	0.451	0.451	0.424	0.455	0.472	0.449
Tianjin	0.215	0.229	0.303	0.187	0.232	0.216	0.278	0.311
Chongqing	0.159	0.176	0.264	0.178	0.224	0.239	0.451	0.463
Heilongjiang	0.154	0.163	0.275	0.155	0.201	0.246	0.198	0.190
Jilin	0.140	0.144	0.209	0.139	0.183	0.196	0.170	0.200
Liaoning	0.318	0.305	0.293	0.217	0.247	0.280	0.257	0.247
Jiangsu	0.649	0.664	0.651	0.694	0.61	0.668	0.584	0.561
Shandong	0.471	0.494	0.541	0.510	0.516	0.557	0.472	0.454
Anhui	0.228	0.242	0.322	0.269	0.305	0.328	0.304	0.318
Hebei	0.245	0.247	0.345	0.249	0.307	0.367	0.348	0.368
Henan	0.255	0.275	0.338	0.295	0.337	0.361	0.380	0.391

Table 2. *Cont.*

Province	2013	2014	2015	2016	2017	2018	2019	2020
Hunan	0.216	0.228	0.298	0.236	0.284	0.319	0.322	0.316
Hubei	0.228	0.245	0.305	0.256	0.287	0.342	0.327	0.305
Jiangxi	0.196	0.216	0.279	0.243	0.269	0.277	0.255	0.279
Shaanxi	0.174	0.184	0.233	0.188	0.218	0.238	0.239	0.244
Shanxi	0.151	0.14	0.222	0.136	0.194	0.228	0.244	0.253
Sichuan	0.261	0.273	0.349	0.289	0.338	0.378	0.712	0.694
Qinghai	0.105	0.114	0.169	0.083	0.118	0.145	0.130	0.162
Hainan	0.082	0.119	0.192	0.134	0.176	0.240	0.181	0.177
Guangdong	0.867	0.857	0.713	0.869	0.610	0.649	0.825	0.747
Guizhou	0.127	0.141	0.285	0.138	0.192	0.288	0.242	0.219
Zhejiang	0.445	0.475	0.534	0.517	0.491	0.501	0.443	0.424
Fujian	0.222	0.235	0.328	0.265	0.305	0.367	0.297	0.267
Gansu	0.102	0.133	0.154	0.157	0.146	0.172	0.189	0.194
Yunnan	0.154	0.158	0.217	0.162	0.198	0.235	0.245	0.249
Inner Mongolia	0.157	0.166	0.231	0.159	0.356	0.246	0.208	0.273
Ningxia	0.090	0.108	0.225	0.105	0.166	0.190	0.165	0.192
Tibet	0.121	0.125	0.205	0.099	0.149	0.237	0.191	0.173
Xinjiang	0.126	0.138	0.206	0.129	0.160	0.225	0.192	0.247
Guangxi	0.146	0.150	0.230	0.159	0.199	0.236	0.249	0.217

Based on Table 2, most of China's 31 provinces effectively improved their logistics industry's high-quality growth level during the sample observation period. Those provinces with a development level between 0.1 and 0.2 were classified as weak, those with a development level between 0.2 and 0.3 were classified as potential, and those with a development level above 0.3 were classified as strong. Comparing the observation samples, it was evident that most eastern Chinese provinces were considered strong, with the highest levels of high-quality growth in the logistics industry. During the observation period, the weaker provinces were mostly located in western China, where development was lower and fluctuated. As a result, the relative position of the level did not change significantly during the sample period, indicating that the trend in each province remained largely unchanged.

2.2. Dynamic Evolution of High-Quality Development of Regional Logistics Industry

2.2.1. Research Methods

Based on the above research results, the kernel-density estimation method was used for analysis in this paper. This method has the advantage of reflecting the probability distribution of the unknown variables contained within the density function in the graph, which can reduce measurement error and reflect the actual value. The central peak can be used to determine the degree of similarity between them. In the case of decreasing similarity the central peak moves to the left, whereas in the case of increasing similarity it moves to the right, and the degree of smoothness can be used to determine how much difference exists between regions. The smoother it is the steeper it is, and vice versa. The calculation method is as follows:

$$f(x) = \frac{1}{Nn}\sum_{i=1}^{n} k\left(\frac{x_i - x}{h}\right) \tag{11}$$

In Formula (11), the broadband is represented by h, the number of observations is represented by N, and the kernel-density function is represented by $f(x)$. The independent and identically distributed observations are denoted by x_i, and the mean is denoted by x. The accuracy of the kernel-density estimation and the smoothness of the kernel-density map are affected by the bandwidth, so the choice of the bandwidth should satisfy the following formula:

$$\lim_{N\to\infty} h(N) = 0 \tag{12}$$

$$\lim_{N\to\infty} h(N) = N \to \infty \tag{13}$$

The kernel function is a weighting function or smoothing function. In this paper, the Gaussian kernel function was used, which is expressed as follows:

$$K(x) = \frac{1}{\sqrt{2\pi}} \exp\left[-\frac{x^2}{2}\right] \tag{14}$$

2.2.2. Dynamic Evolution Process

Using the aforementioned kernel-density approach, this research studied the dynamic evolution process of high-quality growth of China's regional logistics business (see Figures 1–4). In Figure 1, it can be seen that the position of the main peak of the distribution curve shifted to the right over time, indicating that the high-quality growth level of China's logistics industry was generally on the rise, whereas the height of the main peak tended to decrease and the width tended to increase, indicating that the regional difference tended to decrease, and there were small peaks, showing a peak pattern of "one main and one small," indicating that the high-quality growth level of China's logistics industry polarized during the sample observation period.

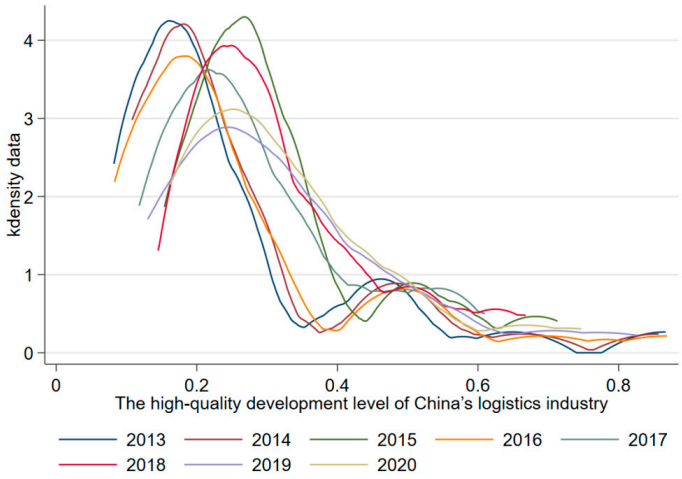


Figure 1. Dynamic distribution of high-quality development of China's logistics industry.

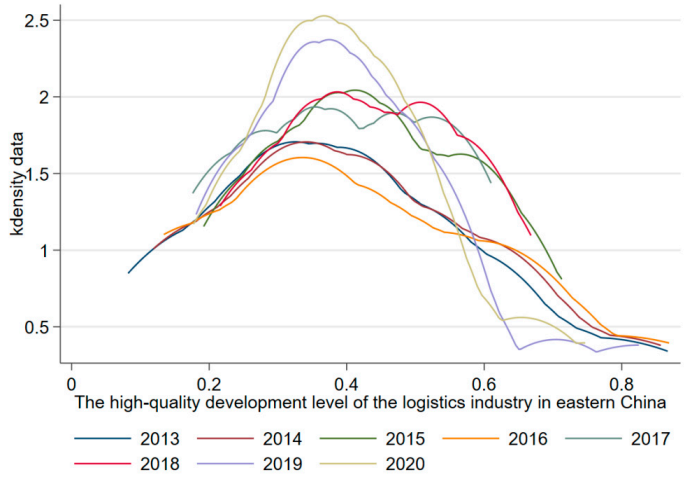


Figure 2. Dynamic distribution of high-quality development of the logistics industry in eastern China.

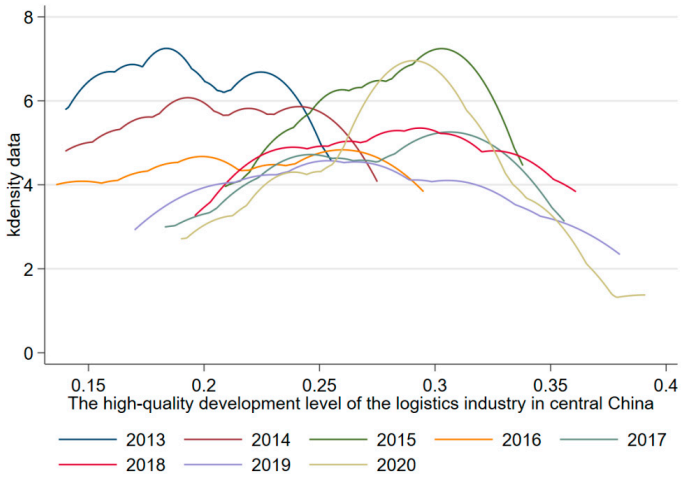


Figure 3. Dynamic distribution of high-quality development of the logistics industry in central China.

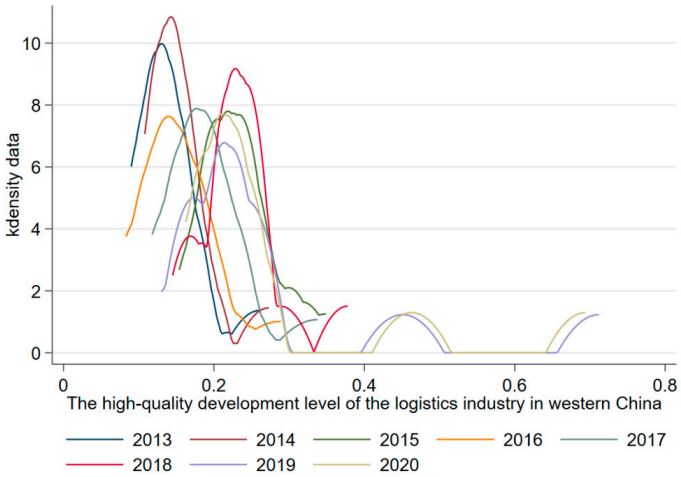


Figure 4. Dynamic distribution of high-quality development of the logistics industry in western China.

As shown in Figure 2, the distribution curve to the right as the main peak position progressively moved to the right, indicating an increase in the difference between the peaks in the eastern region, as well as only one peak, thus indicating that there was relatively high coordination between the provinces within the eastern region, as a result of which no polarization occurred during the observation period. The distribution curve continuously shifted to the right from the perspective of peak evolution, as can be observed in Figure 3, indicating that the high-quality growth level of the central logistics industry was generally improving. In 2015, two main peaks appeared, and the height of the peaks repeatedly decreased first and then increased and the width became wider, indicating that the difference in the central region increased and there was polarization. Based on how the wave peak changed in Figure 4, the distribution curve was shifting to the right, showing that the wave peak's trend was increasing and the width of the difference in the western region was increasing; there was only one main peak, which indicates relative coordination of the provinces in the western region and no phenomenon of polarization.

2.3. Analysis of the Dynamic Evolution Process

This study measured the level of industrial structure upgrading in each region using the industrial structure upgrading coefficient approach. The formula is expressed as follows:

$$INDU = \sum_{t=1}^{3} W_i \times i \quad (15)$$

In Formula (15), *INDU* represents the industrial structure upgrading coefficient, which is obtained by summing the products of the proportion of each industry and its weight, and its value ranges from 1 to 3 for the proportion of industry in GDP.

The results of the industrial structure upgrading level obtained through calculation are shown in Table 3. It can be seen that Beijing, Shanghai, Tianjin, Guangdong, and other provinces had relatively excellent levels of industrial structure upgrading, and all belong to the eastern region. In terms of sub-regions, the level of industrial structure upgrading in eastern China was typically high and exceeded the level of the country as a whole, whereas it was typically low in the central and western regions, particularly in the western region, which is considered to be one of the more backward regions of the nation. Therefore, the level of industrial structure upgrading was divided into regions from high to low: the eastern region, the central region, and the western region.

Table 3. Level of industrial structure upgrading from 2013 to 2020.

Province	Industrial Structure Upgrade Level	Province	Industrial Structure Upgrade Level
Beijing	2.810	Shanxi	2.448
Shanghai	2.668	Sichuan	2.339
Tianjin	2.528	Qinghai	2.254
Chongqing	2.404	Hainan	2.304
Heilongjiang	1.946	Guangdong	2.466
Jilin	2.317	Guizhou	2.310
Liaoning	2.382	Zhejiang	2.466
Jiangsu	2.431	Fujian	2.339
Shandong	2.384	Gansu	2.394
Anhui	2.291	Yunnan	2.302
Hebei	2.31	Inner Mongolia	2.336
Henan	2.302	Ningxia	2.373
Hunan	2.368	Tibet	2.427
Hubei	2.320	Xinjiang	2.294
Jiangxi	2.304	Guangxi	2.243
Shaanxi	2.317		

Further, the dynamic evolution process was analyzed by the kernel density analysis method (see Figures 5–8. In Figure 5, in China's overall sample, the peak of the distribution curve gradually shifted to the right, indicating that the level of China's industrial structure upgrading was generally on the rise. The main peak value of the distribution curve first decreased and then increased, the peak value generally showed an upward trend, and there were regular fluctuations in the level of industrial structure upgrading; the width of the main peak of the distribution curve first became smaller and then larger, indicating that the absolute gap in China's overall industrial structure upgrading level first became smaller and then larger. There was only one main peak, indicating that there was no polarization phenomenon.

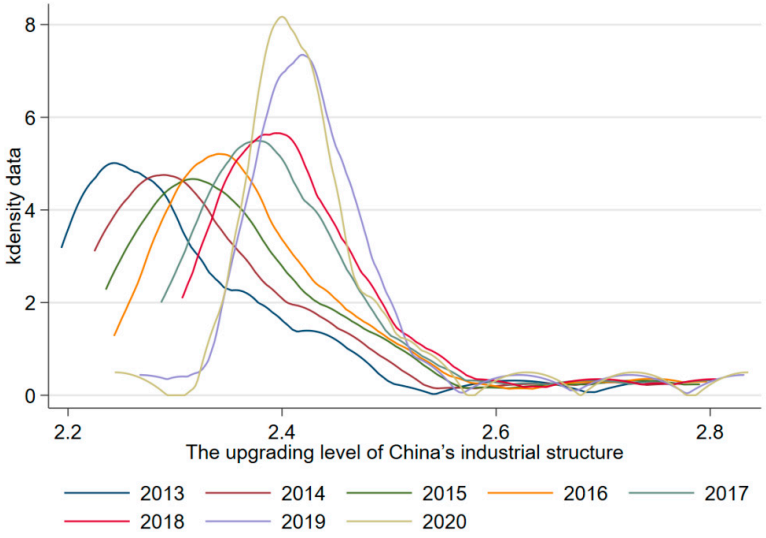


Figure 5. Dynamic distribution of the upgrading level of China's industrial structure.

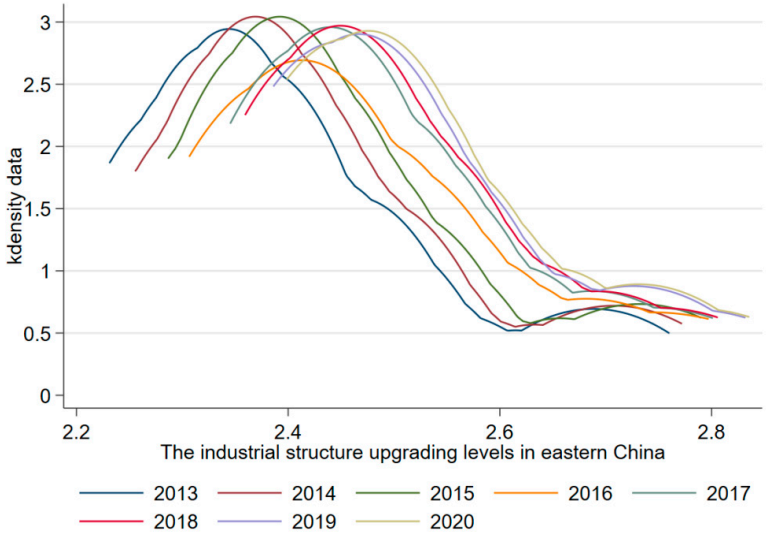


Figure 6. Dynamic distribution of industrial structure upgrading levels in eastern China.

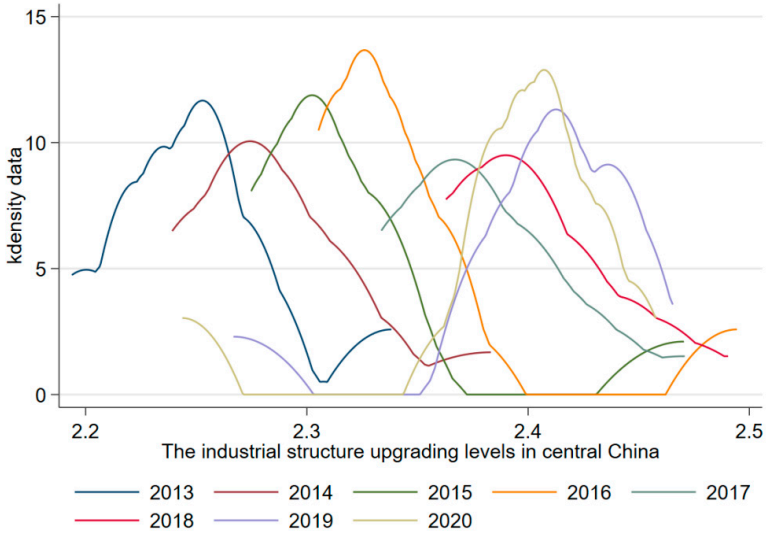


Figure 7. Dynamic distribution of upgrading levels of industrial structure in central China.

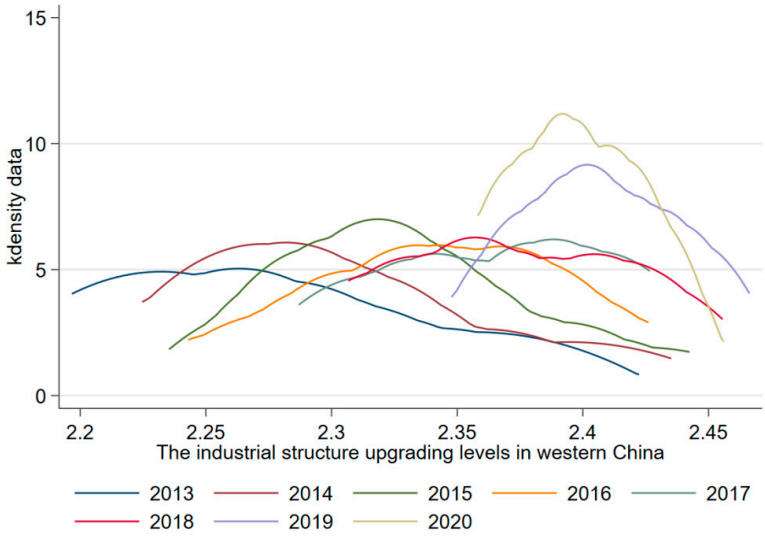


Figure 8. Dynamic distribution of industrial structure upgrading levels in western China.

Observation by region: From Figure 6, the peak of the distribution curve shifted to the right, indicating that the level of industrial structure in eastern China generally showed an upward trend. An increase followed a decrease in the peak value of the main peak in volatility. According to the main peak width of the distribution curve, the main peak width first became larger and then smaller, indicating that the absolute difference in the level of industrial structure upgrading first became larger and then smaller. Moreover, there was only one main peak, indicating that there was no polarization in the eastern region. From Figure 7, it appears that the peak of the distribution curve for industrial structure upgrading generally moved to the right, indicating a general upward trend in the level of industrial structure upgrading in central China. In the central region, the industrial structure upgrading index first rose, then fell, and then rose again, with large fluctuations from the main peak of the distribution curve. As measured by the main peak width of the distribution curve, the main peak width first became smaller and then larger, indicating that the absolute gap first decreased and then increased; in 2016, a small wave peak was evident, indicating polarization in the central region. In Figure 8, it can be seen that the peak of the distribution curve generally moved to the right, indicating that the level of industrial structure upgrading generally rose in western China. The peak value of the peak of the distribution curve showed a trend of first rising, then falling, and then rising; the width of the main peak of the distribution curve continued to increase, indicating that the absolute gap was gradually increasing. In addition, there was only one main peak, indicating that there was no polarization.

2.4. Grey Relational Analysis

This research employed the grey correlation model to investigate the relationship between the high-quality growth of China's regional logistics industry and the upgrading of the industrial structure. The calculation method is as follows:

$$g_i = \sum_{i=1}^{n} \delta_i(k)/n \tag{16}$$

$$\delta_i(k) = \frac{\Delta_{\min} + \rho\Delta_{\max}}{\Delta_i(k) + \rho\Delta_{\max}} (k = 1, 2, \ldots, n) \tag{17}$$

In Formula (17), $\Delta_i(k) = |X_{0i}(k) - X_i(k)|$.

g_i is the grey correlation degree, $\delta_i(k)$ is the correlation coefficient, and ρ is the resolution coefficient, usually taken as $\rho = 0.5$ The calculation results are shown in Table 4 below. It can be seen that the grey correlation degrees were all greater than 0.5, indicating there

was a strong correlation in three regions and the correlations were in descending order: the western region, the eastern region, and the central region.

Table 4. The grey correlation coefficient between the high-quality development of the logistics industry and the upgrading of the industrial structure.

Sample	Correlation
Eastern China	0.64
Central China	0.61
Western China	0.7

3. The Influence Path Test of the High-Quality Development of the Chinese Regional Logistics Industry on the Industrial Structure Upgrading

3.1. Mechanism Analysis

3.1.1. Analysis of the Direct Effect of High-Quality Development of the Logistics Industry on Industrial Structure Upgrading and Its Action Mechanism

According to the development experience of developed countries around the world, the expansion in the service sector's share of the economy as a whole is the key characteristic of industrial structure upgrading. As an important part of the service industry, carrying out high-quality development will help improve the development level of the service industry [18]. Accordingly, the following are the primary ways that the high-quality development of the logistics industry has improved the industrial structure:

First, the logistics industry belongs to the modern service industry. As the industry increases investment in research and development and improves the technical level to achieve innovative development, the quality of development is also improved and the industrial structure is upgraded. Second, industrial integration can be strengthened to help upgrade the industrial structure. Its influence effect is not only manifested in that it can facilitate the development of agriculture, industry, and manufacturing, but also increase the efficiency and effectiveness of various industries, ensure efficient operations in various industries, and enhance the level of integration between agriculture, industry, and service industries to enhance the upgrading of industrial structures [19]. Third, the logistics industry is a composite industry with strong industrial relevance. Developing the logistics industry at high levels requires a coordinated and shared approach, which not only enables the interaction of various elements within the logistics industry but also promotes internal transformation. Moreover, as a binder for different industries, it can better serve other industries, thereby promoting the upgrading of the industrial structure. Therefore, hypothesis 1 proposed in this paper is as follows:

Hypothesis 1: The improvement of the industrial structure will be aided by the high-quality growth of the logistics industry.

3.1.2. Regional Heterogeneity Analysis of the Influence Intensity of High-Quality Development of Logistics Industry on Industrial Structure Upgrading

The characteristics of uneven development of China's regional economy are more prominent. The research mentioned above also demonstrates that the regional logistics industry in China has dramatically diverse levels of high-quality growth. As a result, there is also regional heterogeneity in the driving effect of high-quality development of different regional logistics industries on industrial structure upgrading under the influence of different development levels [20]. Specifically, the following outcomes are possible:

Firstly, in areas where the logistics industry has developed in high quality, if the infrastructure is complete, communication between various industries is frequent; the logistics industry is highly efficient in transportation, has low costs, exchanges resources frequently, and is highly efficient in utilizing resources and focuses on technology. In addition to innovation, the development of the logistics industry at a high level in the region can also contribute effectively to the improvement of industrial efficiency.

Secondly, in areas of average development, when the infrastructure of the logistics industry is generally complete, most industries have low production efficiency, consuming a great deal of resources, which can lead to resource waste. It is possible to save resources and allow enterprises to transform from a development mode of high consumption and high investment to a development mode of efficient use of resources so that resources can be allocated reasonably if the logistics industry develops in such areas in a high-quality manner. Consequently, in such regions, the logistics industry could contribute to the upgrading of the industrial structure to a certain extent.

Thirdly, in areas that are not developing at a high level of quality, the infrastructure for the industry is not perfect, the geographical conditions are not favorable, and the distribution of resources is not balanced. As a result, transportation costs between various industries are high and efficiency is low in these areas. Resource inputs and large-scale expansions promote development, and it has little impact on the allocation of resources to various industries. Then, in this region, the logistics industry has little impact on the upgrading of the industrial structure or has no driving force. Based on the above analysis, hypothesis 2 proposed in this paper is as follows:

Hypothesis 2: Under the heterogeneity of regional development conditions, there is regional heterogeneity in the effect of the logistics industry's high-quality growth on modernizing the industrial structure.

3.1.3. Analysis of the Non-Linear Influence of High-Quality Development of Logistics Industry on Industrial Structure Upgrading and Its Adjustment Mechanism

The existing empirical results show that the modern industrial structure can be effectively promoted by FDI, and this promotion mainly exerts its influence in two ways. First, FDI directly invests in high-end industries and promotes an increase in the proportion of high-end industries; second, FDI acts on relatively low-level industries through technology and management spillovers. However, due to the differences in the attractiveness of FDI in different regions, there are great differences in the stock of FDI in different regions. Therefore, FDI has a certain adjustment effect on the high-quality development of the industry and the impact on the upgrading of the industrial structure will result in regional differences. The connection between FDI and the high-quality development of the logistics industry is as follows:

With the continuous introduction of FDI into the market, it will bring a lot of capital, manpower, and technology to the local area and promote the replacement of technology in various industrial sectors, thereby driving the improvement of production efficiency and the rapid development of various industries [21,22]. According to the flying-geese theory, foreign investment will have a demonstration effect, prompting local logistics enterprises to improve management efficiency by imitating and learning advanced management experience and concepts, driving logistics enterprises in the market to compete for innovation and stimulating the innovation and development level of the logistics industry. The foreign direct investment flowing into the logistics industry will also have spillover effects to improve infrastructure [23], allowing for more labor to invest in the technology-intensive logistics industry, as well as encouraging the efficient flow of production factors and better resource allocation. It tends to be scientific and provides better services for other industries. However, existing studies have also found that there are certain conditions for the spillover effect of FDI. For example, when the development level of the logistics industry in a region keeps a relatively higher level, if the quality of the imported FDI is low, the positive spillover effect cannot be exerted despite the large scale of FDI, so the impact effect will not be significant. On the contrary, when the development level is low, the introduction of larger-scale FDI will facilitate the high-quality development of the logistics industry [24]. Accordingly, FDI will be used to determine the threshold value of FDI under the condition of differences in the level of high-quality growth of the logistics industry, which will have a

nonlinear adjustment effect on the impact of upgrading the industrial structure. Therefore, hypothesis 3 proposed in this paper is as follows:

Hypothesis 3: Controlling other influencing factors, the impact of the high-quality development of the logistics industry on the upgrading of the industrial structure shares a threshold effect of foreign direct investment (FDI).

3.2. Model Construction and Data Source

3.2.1. Model Construction

Combined with the research content, mechanism relationship, and data characteristics of this paper, this paper selected the panel-data model to study the impact effect. Therefore, the econometric model constructed in this paper is as follows:

$$INDU_{it} = \beta_0 + \beta_1 LOG_{it} + \mu_{it} \quad (18)$$

In Formula (18), $INDU_{it}$ is the explained variable, represents the level of industrial structure upgrading in the year t in the region i, and is the explanatory variable. LOG_{it} represents the high-quality development level of the logistics industry in the year t in the region. i. μ_{it} is the random-disturbance term. Existing research shows that factors such as foreign direct investment, labor force, technology input, government intervention, and fixed-asset investment may also affect the upgrading of industrial structure. Therefore, this paper added the above control variables and substituted them into the model to obtain:

$$INDU_{it} = \beta_0 + \beta_1 LOG_{it} + \beta_2 FDI_{it} + \beta_3 LAB_{it} + \beta_4 TEC_{it} + \beta_5 GOV_{it} + \beta_6 PRO_{it} + \mu_{it} \quad (19)$$

In Formula (19), FDI_{it}, LAB_{it}, TEC_{it}, GOV_{it}, and PRO_{it} are foreign direct investment, labor quantity, technology investment, government intervention, and fixed-asset investment in year t in region i, respectively.

To further test whether there is a threshold effect of foreign direct investment between the two, the following threshold panel model was constructed:

$$INDU_{it} = \beta_0 + \beta_1 LOG_{it} + \beta_2 FDI_{it}(FDI_{it} \le \gamma) + \beta_2 FDI_{it}(FDI > \gamma) + \beta_3 LAB_{it} + \beta_4 TEC_{it} + \beta_5 GOV_{it} + \beta_6 PRO_{it} + \mu_{it} \quad (20)$$

In Formula (20), FDI_{it} is the threshold variable, $INDU_{it}$ is the explained variable, LOG_{it} is the core explanatory variable, and γ represents the threshold value to be estimated.

3.2.2. Index Description and Data Sources

This study chose 31 Chinese provinces from 2013 to 2020 as the research sample, taking into account the data accessibility for each indicator. The data came from the "China Statistical Yearbook" and the individual missing parts were replaced by the average value. The definitions and descriptions of each explained variable and control variable are shown in Table 5 below.

Table 5. Definition and description of variables.

Variable Type	Variable Name	Variable Symbols	Variable Definition
Explained variables	Industrial structure upgrading index	INDU	$INDU = \sum_{i=1}^{3} W_i \times i, 1 \leq INDU \leq 3$
Explained variables	High-quality development level of the logistics industry	LOG	The comprehensive evaluation method of entropy-weight TOPSIS is used
Explained variables	Foreign direct investment	FDI	FDI/regional GDP
	The amount of labor	LAB	Natural logarithm of the number of people employed
	Technology investment	TEC	R&D funding/regional GDP
	Government intervention	GOV	Government fiscal expenditure/regional GDP
	Investment level	PRO	Fixed-asset investment/regional GDP

3.3. Empirical Analysis

3.3.1. Analysis of the Baseline Regression Results

Based on the Hausman test and previous research experience, this paper selected the fixed-effect model for regression analysis. Based on the regression results presented in Table 6, it is evident that the coefficient for LOG was 0.214 from the perspective of the overall sample level, which indicates there was a significant effect. Furthermore, the high-quality growth coefficient of the logistics industry was increased by 1% and the upgrading of the industrial structure was increased by 0.214%. As far as the control variables are concerned, technological input and government intervention could have a significant promoting effect, and labor input could also help with the upgrading of industrial structure to a certain extent; however, the promoting effect of foreign direct investment and investment level was not obvious. Hypothesis 1 is verified.

Table 6. Regression results.

Sample	Total Sample from China	East	Central	West
Variables	**INDU**	**INDU**	**INDU**	**INDU**
LOG	0.214 ***	0.233 *	0.600 **	0.109
	(3.61)	(2.09)	(2.52)	(1.07)
FDI	−0.167	−1.310 ***	−10.058 **	0.017
	(−0.57)	(−3.15)	(−2.33)	(0.70)
LAB	0.073 *	0.134	−0.078	0.033
	(1.91)	(1.31)	(−1.51)	(0.12)
TEC	11.919 ***	−0.919	1.057	11.070 **
	(3.01)	(−0.88)	(1.38)	(2.92)
GOV	0.685 ***	1.484 ***	0.813	0.391 *
	(2.84)	(5.60)	(1.37)	(1.92)
PRO	−0.051	−0.144	0.115 **	−0.006
	(−1.42)	(−1.68)	(2.66)	(−0.17)
_cons	1.438 ***	1.193	2.729 ***	1.819
	(5.83)	(1.47)	(6.74)	(0.95)
N	248.000	96.000	72.000	80.000
r^2	0.408	0.574	0.595	0.446

Note: *t* statistics in parentheses; * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

The positive and significant regression coefficients of LOG in the regression model for China's eastern and central regions indicate that the high-quality development of the logistics industry in these two regions could support the upgrading of the industrial structure, according to the regional regression results. The promotion effect on the central region was higher than that in the eastern region. However, in the regression model of the western region, the coefficient was positive, but it did not pass the significance test; it

showed that the high-quality development of the logistics industry in the western region did not have a significant impact.

Combining the above analysis, it was determined that the impact effect had obvious differences at the regional level. A significant impact was felt by the central region, followed by a significant impact by the eastern region, both of which were greater than the national level, but the western region had no significant impact. Hypothesis 2 is verified.

3.3.2. Analysis of the Threshold Regression Results

Although the foregoing examines the direct effects of the logistics industry's high-quality development on the modernization of the industrial structure, it remains to be seen whether there is a threshold between the former and the latter. Therefore, this paper selected foreign direct investment as the threshold variable for further research.

(1) Test of the threshold effect

The level of foreign direct investment was utilized as the threshold variable based on the analysis of the data, and the threshold effect test was run on the industrial structure upgrading index. In Tables 7 and 8, it can be seen that the FDI threshold variable passed the single-threshold test at a significant level of 1%, with a threshold value of 0.0567. In terms of sub-regions, the eastern and central regions of China passed the threshold test at a significant level of 5% and 10%, respectively, and there was only one threshold; however, the western region did not pass the threshold test, i.e., there was no threshold in the western region.

Table 7. Threshold-existence test.

Region	Number of Thresholds	F-Value	*p*-Value	Number of BS	Threshold 10%	5%	1%
National	Single threshold	53.12 ***	0.0000	300	19.1727	23.2492	31.2513
	Double threshold	7.10	0.6967	300	61.2730	74.8125	90.4624
Eastern region	Single threshold	14.83 **	0.0367	300	10.8649	13.4563	24.9269
	Double threshold	11.79	0.2433	300	16.4968	18.7317	24.2929
Central region	Single threshold	15.61 *	0.0933	300	15.2375	19.4040	22.9978
	Double threshold	5.20	0.6700	300	25.9261	42.3264	58.2836
Western region	Single threshold	10.15	0.2100	300	12.1122	15.5513	20.5402
	Double threshold	14.01	0.1700	300	18.1960	26.1658	36.8142

* indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Table 8. Threshold estimates and confidence intervals.

Region	Number of Thresholds	Estimated Value	Confidence Interval
National	Single threshold	0.0567	[0.0493, 0.0750].
Eastern region	Single threshold	0.0191	[0.0174, 0.0209].
Central region	Single threshold	0.0196	[0.0187, 0.0198]
Western region	None	None	None

(2) Analysis of threshold regression results

Furthermore, this paper conducted a threshold-effect test on the overall Chinese sample and sub-regional samples, and the regression results are shown in Table 8. According to the estimation results of the threshold parameters, when the level of foreign direct investment was lower than the threshold value of 0.0567, the regression coefficient of influence effect was 0.240 and significant, indicating that within the first threshold range, the improvement of the industrial structure was significantly accelerated by the high-quality development of the logistics industry, and when the level of foreign direct investment was higher than the threshold value of 0.0567, the regression coefficient was −0.193 and significant, indicating that when the level of foreign investment exceeded the threshold of

0.0567, there was a significant inhibitory effect on the upgrading of the industrial structure. Hypothesis 2 is verified.

In terms of sub-regions, the results are shown in Table 8. When the level of foreign investment in the eastern region did not exceed the threshold value of 0.0191, the impact was positive and significant, whereas when it crossed the threshold value of 0.0191, the improvement of the industrial structure was positively and significantly impacted by the industry's high-quality development, but the positive promotion weakened. In contrast, when the level of foreign investment in the central region did not exceed the threshold value of 0.0196, the impact was not significant, but once the threshold value of 0.0196 was crossed, the upgrading of the industrial structure was positively influenced by the high-quality development of the logistics industry.

3.3.3. Robustness Test

Through the comparison in Table 9, it was found that after changing the measurement method of the explained variable, the coefficient, sign, and significance of the core explanatory variable and the control variable changed but were still within the acceptable range. Therefore, the analysis in this paper passed the robustness test and the regression results were reliable.

Table 9. Panel threshold model regression results.

Variables	Coefficient					
	Overall China Sample		Eastern China Sample		Central China Sample	
LOG	FDI $\leq$ 0.0567 0.240 *** (−4.52)	FDI > 0.0567 −0.193 ** (−2.43)	FDI $\leq$ 0.0191 0.392 *** (4.10)	FDI > 0.0191 0.309 *** (3.64)	FDI $\leq$ 0.0191 0.220 (1.35)	FDI > 0.0191 0.473 *** (3.29)
GOV	0.728 *** (5.05)		1.635 *** (5.26)		0.905 ** (2.36)	
PRO	0.009 (0.46)		−0.219 *** (−4.71)		0.093 *** (2.89)	
LAB	0.082 ** (2.14)		0.141 * (1.91)		−0.047 (−0.81)	
TEC	11.247 *** (6.09)		0.214 (0.16)		0.833 (1.53)	
FDI	0.154 *** (2.69)		−0.879 ** (−3.48)		−12.879 *** (−4.29)	

Note: *t* statistics in parentheses; * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

This study employed the ratio of the production value of the tertiary industry to the output value of the secondary industry to measure the advanced industrial structure to assure the rationality of the model and the dependability of the results. Based on the previous method, the robustness test was conducted. The results are shown in Table 10.

Table 10. Robustness-test results.

Sample Variables	(National) INDU	(Eastern Region) INDU	(Central Region) INDU	(Western Region) INDU
LOG	0.493 **	0.983 *	1.111	0.280
	(2.43)	(1.87)	(1.76)	(0.62)
FDI	−0.195	−3.431	−12.058	1.033 ***
	(−0.14)	(−1.47)	(−0.64)	(2.68)
LAB	0.082	0.689	−0.535 **	0.031
	(0.38)	(0.93)	(−2.32)	(0.43)
TEC	28.593	−6.406	0.150	−0.210
	(1.61)	(−1.53)	(0.04)	(−1.34)
GOV	5.149 ***	9.985 ***	10.261 ***	−0.028
	(3.51)	(4.74)	(4.99)	(−0.35)
PRO	−0.416 *	−1.432 **	−0.027	38.340 **
	(−1.86)	(−3.09)	(−0.12)	(2.10)
_cons	−1.001	−4.997	2.880	0.593
	(−0.70)	(−0.85)	(1.61)	(1.19)
N	248.000	96.000	72.000	80.000
r^2	0.389	0.631	0.780	0.446

Note: *t* statistics in parentheses; * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

4. Results and Discussion

(1) The regional logistics industry's high-quality development level and dynamic evolution process were measured and a high-quality development index system for the industry was built. The main conclusions show that most of the provinces in China effectively improved the high-quality development level of the logistics industry during the sample observation period. Most of the provinces with a relatively high level of high-quality development of the logistics industry belonged to the eastern region and most provinces with a relatively lower level of growth belonged to the western region. These findings are consistent with the results of the previous study. There was a positive correlation between logistics and economic growth, and the level of economic development determined the development level of the logistics industry to a certain extent [25,26]. Observation from the dynamic evolution process: The difference in the high-quality development level of China's logistics industry tended to decrease and appeared to be polarized during the sample observation period. Sub-regional observation: The data in the east and west were relatively centralized and there was no polarization phenomenon, indicating that the development of different provinces in the region was relatively coordinated. The difference in the central region was also increasing and there was an obvious polarization phenomenon. On the other hand, the data in the central region were highly dispersed, indicating that the horizontal distribution in the central region was uneven and the internal difference was large. However, it can be seen from the distribution range that the wave crest in the eastern region was concentrated within 0.4, but 0.4 was the extreme value in the central region, whereas in the western region it was concentrated between 0.1 and 0.2. The overall level was the lowest among the three regions, but the level in the western region tended to increase. This may be due to the good location of the eastern region. The advantages, regional economic development, and infrastructure construction level were better, making the development of the eastern region higher than that of the other regions. To sum up, there were apparent differences in the high-quality level and evolution dynamics of logistics in the three regions, and it was found that the development of the logistics industry and regional economy were interrelated, which generally showed the unbalanced status of "high in the east and low in the west" [27].

(2) The upgrading level of China's regional industrial structure and its dynamic evolution process were measured and the grey correlation between the high-quality development of the regional logistics industry and the upgrading of industrial structure was

analyzed. The findings indicate, in summary, that China's industrial structure upgrading generally trended upward during the sample observation period, with the eastern, central, and western sub-regions ranking from high to low, respectively. This is consistent with the measurement results of Xiao et al. [28]. Observing the dynamic evolution process, it is clear that there was no polarization phenomenon despite the variations in the degree of industrial structure upgrading initially becoming smaller and then becoming greater. Sub-regional observation: The differences in the industrial structure upgrading in eastern China first increased and then decreased, and there was no polarization phenomenon. Polarization first became apparent in 2016; however, the disparity in the central region's industrial structure upgrade level had previously been minor. The level of industrial structure upgrading in the western region generally showed an upward trend and polarization was not observed. From the perspective of grey correlation, the high-quality development of the logistics industry in each region of China had a strong correlation with the upgrading of the industrial structure and the correlations were in descending order: the western region, the eastern region, and the central region, respectively. The geographical location, economic development, personnel quality, and other production factors may have affected the process of industrial diversification. The process of industrial restructuring in the western region may not have conformed to the local development capacity due to the backwardness of various production factors [29], resulting in insufficient development momentum, which not only prevents the logistics industry from developing in a high-quality way but also prevents the industrial structure from being upgraded, making the two show a high correlation.

(3) The theory put out by the theoretical analysis was confirmed, as the impact mechanism and direct influence effect of the high-quality development of China's regional logistics industry on the upgrading of the industrial structure were examined. The conclusion shows that, first, the high-quality growth level of the logistics industry had a favorable impact on industrial transformation from the standpoint of China's total sample level. Past research also shows that "high-quality development" can promote the "transformation and upgrading of industrial structure," which also has particular applicability in the logistics industry [30]. Second, implementing a modern logistics system and strengthening the infrastructure are the prerequisites for achieving high-quality industrial development [31]. Therefore, this paper discussed the impact of high-quality logistics development on upgrading industrial structures. The results show that regional heterogeneity was in effect. The main reason is that the logistics industry, as a derivative industry, is largely affected by the unbalanced development of China's regional economy, leading to regional heterogeneity of impact effects. The high-quality growth of the logistics industry in China's eastern and central regions is having a positive influence on the modernization of the industrial structure, according to the regional regression results. The primary cause is that the infrastructure in the western region is not ideal, the economic level is low, and the high-quality development of the logistics industry is challenging and low-level, so it does not significantly contribute to the industrial structure's modernization. As far as control variables are concerned, the effect of each region fluctuated. For example, government intervention in the eastern and western regions significantly promoted the upgrading of industrial structure, whereas it was not significantly promoted in the central region.

(4) FDI plays a decisive role in the economy of developing countries such as China. It interacts with the upgrading of industrial structure and has regional heterogeneity [32,33]. Therefore, using the panel threshold model, this paper further tested the threshold effect of China's overall sample and sub-regional samples. Based on the results, it is obvious that after the introduction of foreign direct investment exceeded the threshold value, there was no improvement in the high-quality growth level of the logistics industry that would lead to an upgrade of the industrial structure. This may be because FDI companies that have just entered the Chinese market usually adopt the

form of joint ventures. As foreign-invested companies gain a deeper understanding of the local market, they tend to become sole proprietorships, and existing research indicates that with the increasing tendency of foreign-invested firms to become sole proprietorships, China's control over the logistics industry has weakened. In the eastern and central regions, there was a threshold value, but not in the western regions, and once the level of foreign investment in the eastern region exceeded the threshold value, the positive role of the high-quality growth of the logistics industry in promoting the upgrading of the industrial structure deteriorated, whereas the central region did not have a threshold value. After the level of foreign investment crossed the threshold, the positive role of the high-quality development level of the logistics industry on the upgrading of the industrial structure changed from insignificant to significant. FDI was positive for the industrial structure, but there were regional differences in absorptive capacity [34], probably because 80% of China's foreign investment is concentrated in the eastern region, whereas only 20% is concentrated in the central and western regions [35,36]. In addition, the scale of foreign investment introduced in the eastern region is increasing, but the quality is not high. Therefore, in enhancing FDI, we must attach great importance to guiding high-quality FDI and foreign companies to enter to improve competitiveness [37]. Despite this, the central region's relatively low level of foreign investment may be able to positively influence the logistics industry's rate of qualitative growth, thereby assisting in the process of modernizing the industrial structure.

5. Conclusions

The logistics industry's significance is becoming more and more obvious. In addition to fostering economic growth, the high-quality development of logistics also continuously fosters the internal modernization and expansion of the logistics sector, which in turn fosters the modernization of the industrial structure. The influence and mechanism of the high-quality development of the logistics industry on the upgrading of the industrial structure are therefore thoroughly examined in this paper based on the body of existing research. This is of practical significance for the formulation of differentiated high-quality logistics development strategies in different regions and has important theoretical significance for the exploration of the path of industrial structure upgrading.

The innovations of this study are as follows: First, the index system of the regional economic development level is introduced while taking into account the derivative characteristics of the logistics industry, and a comprehensive evaluation index for the high-quality development of the regional logistics industry is comprehensively constructed. In addition, it particularly examines the influence mechanism, influence effect, and regional heterogeneity between the two as it dynamically explores the dynamic evolution process of the high-quality development of the regional logistics industry and the upgrading of the industrial structure. Third, it confirms that FDI has a regulatory impact on the high-quality growth of the logistics industry and that this impact has a nonlinear effect on the modernization of the industrial structure. Fourth, this study not only adds to the body of knowledge but also has reference value for the global improvement of industrial structure and the high-quality growth of regional logistics.

Based on the above research conclusions, this paper puts forth the following revelation: First, collaborative regional growth needs to be considered for the logistics industry to expand in a high-quality manner. Regions with good development levels need to aid the growth of relatively backward areas as far as possible in the development process to achieve shared growth. Secondly, the policy suggestions of innovation-driven strategy and regional economic development strategy need to be adopted to adjust the input situation of logistics industry technology improvement and labor supply, which has promoted upgrading industrial structure. Third, in the introduction of FDI, joint ventures and cooperation should still be regarded as the main form of FDI cooperation and the control over the logistics enterprises' guidance and development direction should be strengthened.

Fourth, the introduction threshold and quality of FDI should be continuously improved for the eastern region with large FDI stock. However, for the economically underdeveloped provinces in the central and western regions, because their opening up is still insufficient, in increasing the foreign investment in the logistics field, it is necessary to improve the location conditions, focus on improving the infrastructure, and increase the attraction of foreign investment [38].

This study still has some shortcomings and limitations. First, due to the time limit and the difficulty of obtaining some data, the research needs to be more thorough. Second, our study stopped short of examining whether the variations in the high-quality development levels of the logistics industry generally and between different areas are converging or diverging. If there are differences, what are the influencing factors behind them? Last but not least, due to a lack of time and space, in the evaluation of the effect of the high-quality development of the logistics industry on the modernization of the industrial structure, there is no analysis of the possible moderating effects or interactions of control variables on high-quality development, which will need to be extended in future research.

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