Measurement and Analysis of Logistics Industry Efficiency Management under High Quality Development-Taking Shandong Province as an Example

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Abstract. Based on 3-year data of 16 prefecture-level cities in Shandong Province, the article constructs an evaluation index system to measure the efficiency level of the logistics industry and establishes the Dagum Gini coefficient to analyze the spatial differences and sources of the efficiency of the logistics industry. The results of the study show that: (1) the efficiency level of logistics industry in 16 prefecture-level cities in Shandong Province has been improving, and there is an obvious spatial imbalance between the cities; (2) the overall Gini coefficient of logistics industry efficiency shows a "V"-shaped trend, with the largest difference in the efficiency level of the logistics industry in the Lunan Economic Circle, and the most significant difference between the Jiaodong and Lunan Economic Circle, and the hypervariable density is the highest. The difference between Jiaodong and Lunan Economic Circle is the most significant, and the hypervariable density gradually becomes the main factor determining the spatial difference of logistics industry efficiency.

Keywords: Logistics Industry Efficiency; Mutation Level Method; Regional Differences; Shandong Province

1 INTRODUCTION

With the new trend of China's economy shifting from sustained growth to high-quality development, the logistics industry, as a basic service industry, has gradually integrated more functions in the course of its industry development, and has gradually become an important part of the tertiary industry. Meanwhile, the development speed and quality of the logistics industry has become an important indicator for assessing economic strength. Therefore, exploring the efficiency development of logistics industry has become a core issue in the field of management.

At present, the efficiency of logistics industry has attracted the attention of a wide range of scholars. Wang Wensheng et al. used a three-stage DEA model to analyze the logistics efficiency of the provinces in the Bohai Rim region, and concluded that the logistics efficiency was significantly affected by environmental factors [1]. Bin C et al.

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took the green logistics efficiency of China's provincial logistics industry as the research object and found that the green logistics efficiency was at a low level, while showing a zonal pattern of high in the east and low in the west [2]. Gong Xue et al. took 31 provinces in China as the research object, and found that the development of China's logistics industry showed a geographical difference of "strong in the east and weak in the west" [3]. Liu Hongwei et al. explored 69 logistics hub cities and found that the average annual logistics efficiency of the eastern hub cities has the highest value[4].Yang Bo et al. measured and explored the green logistics efficiency of agricultural products in 30 provinces, and found that the overall logistics efficiency is low, and shows the geographical difference of high in the Middle East and low in the West[5].조성제 analyzes the impact of logistics efficiency on Korea's agricultural exports to the U.S [6]. Qin Wen analyzed from both time and space perspectives and found that the overall efficiency of the logistics industry in the Guangdong-Hong Kong-Macao Greater Bay Area is on the rise, with an imbalance in development between regions[7].

In summary, there is a certain foundation for research on logistics industry efficiency, but there are still problems such as large differences in evaluation indicators, single measurement method and lack of regional specificity. Therefore, this paper constructs the evaluation index system from the four dimensions of innovation development, scale development, openness and shared development, measures the efficiency of the logistics industry by using the entropy value-mutation level method, and analyzes the spatial differences and sources of the efficiency of the logistics industry of the three major economic circles by using the Dagum Gini coefficient.

2 RESEARCH METHODS AND INDICATOR SELECTION

2.1 Entropy Value-mutation Level Method

The entropy value-mutation level method is a comprehensive assessment method that takes topology as a tool and analyzes the ranking of evaluation targets based on the theory of structural stability. The method requires a multi-level decomposition of the evaluated target, with the help of mutation theory and fuzzy mathematics theory comprehensive application to get the mutation fuzzy affiliation function, the use of the normalization formula to find out the function, and the evaluation indexes according to the size of the ranking, to get the final score of the efficiency of the logistics industry. The specific model refers to the research of Tang Jianrong [8]. Common types of mutation models are butterfly mutation, swallowtail mutation and cusp mutation as shown in Table 1.

Table 1. Types of mutation models

typology	mould	normalization equation
spike mutation	$f(x) = x^4 + ax^3 + bx$	$x_a = \sqrt{a}\ x_b = \sqrt[3]{b}$
swallow-tailed mutation	$f(x) = \frac{1}{5}x^5 + \frac{1}{3}ax^3 + \frac{1}{2}bx^2 + cx$	$x_a = \sqrt{a}\ x_b = \sqrt[3]{b}\ x_c = \sqrt[4]{b}$
butterfly mutation	$f(x) = \frac{1}{6}x^6 + \frac{1}{4}ax^4 + \frac{1}{3}bx^3 + \frac{1}{2}cx^2 + dx$	$x_a = \sqrt{a}\ x_b = \sqrt[3]{b}\ x_c = \sqrt[4]{c}$ $x_d = \sqrt[5]{d}$

2.2 Dagum Gini Coefficient

In this paper, Dagum Gini coefficient is used to analyze the geographical differences and sources of logistics industry efficiency in Shandong Peninsula. In order to compare the differences in the efficiency of the logistics industry in each region, Shandong Peninsula is divided into the provincial capital economic circle, Jiaodong economic circle and Lunan economic circle, and Refer to the study of Li Yan [9] and Cheng Changchun[10] for the specific model.

Dagum Gini coefficient formula:

$$G = \frac{\sum_{j=1}^{k}\sum_{h=1}^{k}\sum_{i=1}^{n_j}\left|y_{j,i} - y_{h,y}\right|}{2\mu n^2}$$

The formulae for calculating the intra- and inter-regional Gini coefficients are as follows:

$$G_w = \sum_{j=1}^{k} G_{jj} P_j S_j$$

$$G_{jj} = \frac{\sum_{i=1}^{n_j}\sum_{\gamma=1}^{n_h}\left|y_{j,i} - y_{i,\gamma}\right|}{2\overline{Y}_j n_j^2}$$

$$G_t = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}\left(P_j S_h + P_h S_j\right)\left(1 - D_{jh}\right)$$

2.3 Indicator Selection

According to the findings of the existing inquiry, there has not been a specialized industrial zoning for the logistics industry. Only the transportation, warehousing and post and telecommunications industries are taken as the core of measuring the logistics industry. Following the principles of purposefulness and desirability, four dimensional

indicators are determined after summarizing the existing inquiry. The indicator system is shown in Table 2.

Table 2. Evaluation index system of logistics development quality in Shandong Province

Basic indicators	Level 1 indicators	Secondary indicators	unit
Innovative development	Invest in innovation	R&D expenditures	size
		Science and technology expenditures/public finance budget expenditures	%
	Innovative outputs	Number of patents granted	size
	Reserves	Number of students enrolled in ordinary colleges and universities	Thousands of people
Scale development	Total size of the logistics industry	Freight turnover	Billion tons/km
		Freight volume	Ten thousand tons
	Operational scale	Actual utilization of foreign direct investment	people
		Fiscal expenditures for transportation	Hundred million yuan
	Level of government support	Share of fiscal expenditure on logistics in total local fiscal expenditure	%
Opening	Open level	Total value of imports and exports	Ten thousand dollars
	Foreign investment	Amount of foreign direct investment actually utilized	Hundred million yuan
		Number of foreign-invested enterprises	size
Shared development	Logistics services	The proportion of total postal and telecommunications services in total population at the end of the year	%
	infrastructure	Number of post offices at the end of the year	size
	Transportation equipment	Truck ownership	Ten thousand units

3 Empirical Analysis

3.1 Results of Logistics Industry Efficiency Measurement

Based on the data of 16 prefecture-level cities in Shandong Province in 2020, 2021 and 2022, the efficiency of logistics industry is measured by entropy value-mutation level method using the logistics industry efficiency evaluation index system. All scores are between 0 and 1, and the larger value represents the higher level of logistics industry efficiency, and the results are shown in Table 3.

Table 3. Evaluation results of logistics industry efficiency in each prefecture-level city

Citys	2020	2021	2022	aver-	Citys	2020	2021	2022	average
Qingdao	0.994	0.997	0.998	0.996	Dongying	0.553	0.528	0.499	0.527
Yantai	0.874	0.876	0.899	0.883	Dezhou	0.667	0.653	0.667	0.662

Weihai	0.783	0.760	0.712	0.752	Liaocheng	0.611	0.589	0.589	0.596
Zaozhuang	0.406	0.399	0.365	0.390	Binzhou	0.656	0.650	0.703	0.670
Rizhao	0.483	0.477	0.545	0.502	Jinan	0.862	0.864	0.891	0.872
Linyi	0.775	0.779	0.833	0.796	Weifang	0.850	0.837	0.882	0.856
Jining	0.759	0.778	0.780	0.772	Zibo	0.699	0.740	0.767	0.735
Heze	0.593	0.604	0.540	0.579	Taian	0.509	0.610	0.679	0.599
Average 2020		0.692	Average 2021		0.696	Average 2022		0.709	

From a horizontal perspective, the logistics industry in Shandong Province has experienced rapid growth, and its final score of logistics industry efficiency has shown a continuous rise in general, with the average value of the score rising from 0.692 in 2020 to 0.709 in 2022, which is a remarkable development and a high overall level. During the "14th Five-Year Plan", the importance of optimizing the cargo transportation structure is clearly emphasized, and a modern logistics network with balanced supply and demand, close internal and external connections, high efficiency, safety, intelligence and environmental friendliness will be successfully established by 2025, which will bring new opportunities for the logistics industry to develop and significantly improve the overall scale and development level of the logistics industry. development level of the logistics industry. From a vertical perspective, there are obvious differences in the efficiency of the logistics industry among some cities. Qingdao has long occupied the top position in the development of the logistics industry, and compared with Zaozhuang, which is at the bottom of the list, the difference in the evaluation value of the efficiency of the logistics industry is between 0.580 and 0.640, and there is a large gap in the efficiency of the logistics industry among the prefectural-level cities. From a macro point of view, cities such as Qingdao, Yantai, Jinan and Weifang show a higher overall level of logistics industry efficiency, while cities such as Zaozhuang, Dongying and Heze are always in a more disadvantaged position in this regard.

3.2 Spatial Characterization of Logistics Industry Efficiency

As can be seen from Table 3, the efficiency of logistics industry in Shandong Province shows obvious geographical differences, which indicates that there is a significant polarization effect among cities and a serious imbalance in the efficiency of logistics industry. The high-efficiency cities are Jinan, Weifang, Qingdao, Yantai and Linyi, mostly concentrated in economically developed cities. Among them, the high efficiency level of Linyi's logistics industry is due to its convenient location at the intersection of Jiaoji Railway, Beijing-Shanghai Railway and Jinan-Rizhao Expressway; at the same time, the city possesses a well-developed industrial system, which creates a greater demand for logistics services. On the other hand, the less economically developed regions are in a lower state, especially Zaozhuang, Dongying and Rizhao, whose economic growth is relatively lagging behind, and the effect of technological innovation is not prominent, so it is necessary to improve the environment for the development of the logistics industry as a whole. It can be seen that the difference of logistics development in each city is affected by the economic development status.

3.3 Analysis of Spatial Differences and Sources of Efficiency in the Logistics Industry

In order to further analyze the regional differences and sources of logistics industry efficiency in Shandong Province, Dagum's Gini coefficient is applied to measure the internal differences, regional differences and cross-regional differences of the three major economic circles, and a comparative analysis is carried out. The specific results are shown in Table 4.

Table 4. Gini coefficients and their decomposition results for 2020, 2021 and 2022

	Economic circle	2020	2021	2022
Intra-regional variation	Jiaodong	0.112	0.117	0.134
	Provincial capital	0.088	0.083	0.092
	Lunan	0.126	0.128	0.164
Regional differences	Jiaodong-Provincial capital	0.151	0.144	0.148
	Jiaodong-Lunan	0.162	0.158	0.184
	Provincial capital-Lunan	0.122	0.121	0.146
Contribution rate (%)	Intra-regional variation	27.508	28.059	28.818
	Regional differences	38.654	35.729	32.598
	Supervariable density	33.839	36.212	38.584
Population gini coefficient		0.129	0.128	0.143

As shown in Table 4, during the sample period, the overall difference in the efficiency of the logistics industry shows a "V" shaped trend, and the overall Gini coefficient ranges from 0.127 to 0.142, with the overall Gini coefficient in 2022 being the largest. At the same time, there are obvious differences in the intra-regional differences in the efficiency of the logistics industry among the three major economic circles, specifically, the Lunan Economic Circle has the largest degree of difference, and the Provincial Capital Economic Circle has the smallest difference. The reason for this is that the Provincial Capital Economic Circle forms a development pattern centered on Jinan, which has a stronger driving role in economy, industrial structure and policy. From the perspective of evolution trend, Lunan and Jiaodong Economic Circle show a rising characteristic, with an average annual growth rate of 4.31% and 2.81% respectively; while the Provincial Capital Economic Circle shows a declining and then rising trend. To summarize, there are still significant geographical spatial differences in the efficiency of the logistics industry in Shandong Province, and the intra-regional differences among the three economic circles generally show a widening trend.

In terms of inter-regional differences, the inter-regional differences between Jiaodong and Lunan Economic Circle are the most significant, with a mean value of 0.168. The difference between the provincial capitals and Lunan Economic Circle is the smallest. In addition, the three economic circles show a "V-shaped" trend, the development of logistics industry efficiency between the cities is not balanced. Therefore, it is necessary to appropriately strengthen the synergistic development of the region's logistics business, promote economic development, and government guidance and support, so as to promote the development of the logistics industry. In terms of contribution rate, the inter-regional difference and hypervariance density have been kept greater than the intra-regional contribution rate, and the inter-regional contribution rate is in a state of gradual decline, while the intra-regional difference and hypervariance density show a

rising trend. In addition, the spatial difference in the efficiency of the logistics industry is transformed from inter-regional difference to the dominance of hypervariable density, and the contribution rate of intra-regional difference is minimized.

4 CONCLUSIONS AND RECOMMENDATIONS

Based on three years' data in Shandong Province, this paper measures the logistics industry efficiency of 16 prefecture-level cities using entropy value-mutation level method, and reveals the regional differences and sources of logistics industry efficiency by constructing Dagum Gini coefficient model. The exploration results show that: (1) there are obvious imbalances among cities in Shandong Province in the level of logistics logistics industry efficiency, and the economic situation plays a decisive role in logistics development; (2) the spatial differences in logistics industry efficiency in Shandong Province are significant. The overall difference in the efficiency of the logistics industry shows a "V" shaped trend, the Lunan Economic Circle has the largest degree of intra-regional differences; in the inter-regional differences, the most significant differences between Jiaodong and Lunan Economic Circle; the main source of the spatial differences in the efficiency of the logistics industry from the intra-regional differences into the hyper-variable density. Based on the above conclusions and analyses, the following suggestions are made: (1) the efficiency level of the logistics industry manifests itself as a geographical difference, for this reason, neighboring cities should strengthen a series of measures such as industrial synergism, resource sharing, and inter-regional cooperation to promote the integration and development of regional logistics; (2) to strengthen the logistics technological innovation and infrastructure R&D, to promote Shandong Province's logistics industry in the direction of digitalization and intelligence, and to improve the transportation, warehousing, efficiency of transportation, warehousing, distribution and other links.

REFERENCES

1. WANG Wensheng, KAO Xiaoxuan. Study on measuring logistics efficiency in Bohai Rim under the perspective of high-quality development--Based on three-stage DEA model[J]. Business Research,2021(04):75-84.
2. Bin C,Fang L,Yina G,et al.Spatial and temporal evolution of green logistics efficiency in China and analysis of its motivation[J]. Development and Sustainability,2022,26(2):2743-2774
3. Gong Xue. Measurement of regional logistics efficiency and analysis of influencing factors[J]. Statistics and Decision Making,2022,38(12):112-116.
4. LIU Hongwei,YANG Ronglu,SHI Hongjuan. Spatial and temporal differences in logistics industry efficiency and its convergence in logistics hub cities[J]. Journal of Beijing Jiaotong University (Social Science Edition),2022,21(02):122-133.
5. YANG Bo,WANG Zhengbing. Influence of green technology innovation on the efficiency of green logistics of fresh agricultural products--Based on the moderating effect of industrial agglomeration[J]. China Circulation Economy,2023,37(01):60-70.

6. Analysis of the effect of logistics efficiency of ASEAN+3 countries on Korean agri-food trade[J].Trade Information Research,2021,23(4):
7. Qin Wen. Spatio-temporal evolution and improvement path of logistics industry efficiency in Guangdong, Hong Kong and Macao Greater Bay Area[J]. China Circulation Economy, 2020,34(09):31-40.
8. TANG Jianrong,QI Mengyuan. Measurement of competitiveness level of regional logistics industry and analysis of influencing factors[J]. Statistics and Decision Making, 2022,38(21):72-76.
9. LI Yan, WANG Keqiang, HUANG Jing. Research on the coupled and coordinated development of logistics industry and commerce industry in the city cluster in the middle reaches of the Yangtze River under the new development pattern[J/OL]. Yangtze River Basin Resources and Environment,1-19[2024-01-21].
10. YAN Xiang,CHENG Changchun. Research on the unbalanced development of science and technology innovation efficiency and ecological environment in the Yangtze River Economic Belt--Based on a double-threshold panel model[J]. Soft Science,2018,32(02):11-15.