ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

Analysis of the Operational Efficiency of Listed Logistics Companies based on DEA and the Malmquist Index

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Abstract

Using panel data from 50 listed logistics companies in China spanning the period 2014–2023, this study analyzes the operational efficiency of China's listed logistics enterprises from both static and dynamic perspectives by applying the DEA-BCC model and the Malmquist productivity index.Through cross-sectional and longitudinal comparisons of the 50 listed logistics companies, the results indicate that the development of logistics enterprises across different regions in China is highly uneven.Specifically, logistics enterprises in the western region exhibit relatively high overall efficiency and pure technical efficiency,while those in the eastern region demonstrate higher scale efficiency.Moreover, the total factor productivity of China's logistics enterprises reached its peak in 2019.Overall, pure technical efficiency is identified as the primary factor influencing the high operational efficiency of listed logistics companies in China.Based on these findings, China's logistics industry should focus on improving technological capabilities and the application of new technologies, enhancing talent development and management systems, and strengthening governmental support.

Keywords

Listed Logistics Companies; DEA Model; Malmquist Index; Operational Efficiency.

1. Introduction

With the deepening of a new wave of technological revolution and industrial transformation, emerging technologies and their industrial applications have accelerated the restructuring of the international production and trade system, driving global industrial chains toward digitalization, green development, and integrated development.Amid the intensified strategic competition between China and the United States and the impact of regional conflicts, certain segments of global industrial and supply chains have been disrupted, leading to increasing trends of localization, regionalization, and supply chain shortening.Against this backdrop, the accelerated restructuring of the global production layout has made the upgrading of China's industrial chains not only an inevitable response to changes in global production patterns but also a proactive choice to ensure the high-quality development of the new development paradigm.

Against the background of transformations in global industrial chains and the restructuring of production layouts, the Central Committee of the Communist Party of China has made a major strategic decision to build a new development paradigm in which domestic and international circulations mutually reinforce each other.Under this new development paradigm, achieving coordinated, efficient, and secure development of domestic and international value chains has become a core task.As a fundamental sector of the national economy, the logistics industry plays a crucial role in economic growth and the efficient allocation of resources.In 2024, the total value of social logistics in China reached 360.6 trillion yuan, representing an increase of

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

approximately 147.1 trillion yuan compared with 2014, with a growth rate of 68.90%.These figures indicate that China's logistics industry has experienced rapid growth over the past decade, and investigating the efficiency of logistics enterprises is of significant theoretical and practical importance for uncovering the industry's potential growth drivers and promoting high-quality and efficient development of the logistics sector.

Existing studies on the efficiency evaluation of the logistics industry have predominantly employed data envelopment analysis (DEA), with a particular focus on the static and dynamic measurement of logistics efficiency.Some scholars have taken regions or provincial-level industries as their units of analysis and applied DEA models in combination with the Malmquist productivity index to conduct both static and dynamic efficiency evaluations from multiple dimensions, including changes in pure technical efficiency, technical efficiency, technological progress, and scale efficiency, thereby revealing the actual development conditions of specific provinces or regions (Kozowska, 2014[1]; Liu et al., 2019[2]; Yao et al., 2022[3]).Another strand of the literature constructs comprehensive efficiency evaluation indicator systems and employs DEA models to conduct empirical analyses of firms within specific industries, measuring their efficiency levels and examining the influencing factors (Ai, 2008[4]; Markovits-Somogyi, 2014[5]; Li, 2017[6];Hu, 2011[7]).

However, existing studies still exhibit several limitations. In terms of research focus, most studies on logistics efficiency have adopted regions or other macro-level units of analysis, while relatively little attention has been paid to logistics enterprises at the micro level, resulting in a lack of firm-level empirical evidence.In response to this research gap, this study adopts a micro-level perspective and selects 50 listed logistics companies in China as the research sample, utilizing panel data covering the period from 2014 to 2023.This study is structured in two main stages. First, the selection of the research sample and the determination of input–output indicators are described, followed by an evaluation of the operational efficiency of logistics enterprises from both static and dynamic perspectives using the DEA and Malmquist models. Based on the empirical results, the study further analyzes the underlying causes and proposes corresponding policy and managerial recommendations.

2. Indicators Selection and Data Sources

2.1. Principles for Indicator Selection

Constructing a scientific and well-structured evaluation indicator system is crucial for the study of operational efficiency in logistics enterprises.To ensure the accuracy and reliability of the research results, this study establishes an evaluation indicator system for the operational efficiency of logistics enterprises based on the following principles.

(1) Scientific validity. The principle of scientific validity requires that the design of the indicator system adhere to scientific methods and established theoretical principles, ensuring that the selected indicators accurately and comprehensively reflect the characteristics and underlying attributes of the research object. This principle constitutes the primary foundation of indicator system construction and underpins the validity of the evaluation results.

(2) Systematic coherence. The principle of systematic coherence emphasizes that the construction of an indicator system should account for the internal relationships and interactions among indicators. This principle is indispensable in empirical research, as the degree of interconnection among indicators determines both the scientific rigor and operational feasibility of the evaluation system. Specifically, a systems-oriented approach should be adopted to establish relational frameworks among indicators, identify their interaction mechanisms, and ensure that the indicator system comprehensively captures all relevant dimensions of the research object rather than focusing on a single aspect.

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

(3) Practical feasibility. The principle of practical feasibility requires that, in addition to representativeness, the selected indicators be measurable and accessible in practice. Adhering to this principle ensures that the evaluation indicators are aligned with actual research conditions and objectives, thereby avoiding overly idealized or excessively complex indicators that are difficult to operationalize.

2.2. Selection of Input and Output Indicators

After selecting the DEA-BCC model and the Malmquist productivity index as the methods for measuring the operational efficiency of listed logistics companies, it is important to note that data envelopment analysis (DEA) does not require the prior specification of a production frontier function and directly evaluates efficiency based on input–output data. Consequently, the construction of the input–output indicator system for listed logistics enterprises plays a decisive role in the accuracy and effectiveness of operational efficiency measurement.

A review of the existing literature indicates that scholars tend to emphasize data completeness and multidimensionality when constructing evaluation indicator systems, frequently extracting data from the annual financial statements of listed companies to capture firms' operational performance across different stages. Accordingly, by systematically collecting and synthesizing prior studies, this paper summarizes the input and output indicators commonly employed in DEA-based efficiency evaluations, thereby facilitating the scientific and rigorous selection of the evaluation indicator system. Building upon prior studies and the principles of indicator selection, and in consideration of the context of intelligent transformation, this study selects indicators from key input–output factors related to labor, capital, and physical assets. Specifically, fixed assets, operating costs, administrative expenses, and employee compensation payable are chosen as input indicators, while operating revenue and earnings per share are selected as output indicators.

Table 1. Evaluation Indicator System for the Operational Efficiency of Listed Logistics Companies

Input Indicators	Output Indicators
Total assets Current assets Operating costs Administrative expenses	Net profit Operating revenue

2.3. Data Sources and Sample Selection

To effectively evaluate corporate operational efficiency while ensuring that the data used in this study are authoritative, reliable, and readily accessible, this paper employs data from Chinese listed logistics enterprises covering the period from 2014 to 2023. According to the Industry Classification Results of Listed Companies (Third Quarter of 2021) issued by the China Securities Regulatory Commission (CSRC), although there is no specific category labeled "logistics industry," the majority of listed companies classified under "Transportation, Storage, and Postal Services" primarily engage in logistics-related businesses. Based on the definition of logistics enterprises, these firms are therefore regarded as representative logistics companies in this study.

To ensure the accuracy and representativeness of the sample selection, the following criteria are applied:

First, among companies classified under "Transportation, Storage, and Postal Services," only listed firms whose primary business activities and operating scope are predominantly logistics-related are selected.

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Second, sample firms are required to have complete data for the period 2014–2023; companies with less than ten years of listing history or incomplete indicator data are excluded.

Third, firms that meet the above criteria but were designated as "ST," "*ST," or experienced other abnormal operating conditions during the period 2014–2023 are excluded.

Fourth, in accordance with the basic principles of DEA, to ensure the validity of efficiency estimation results, the number of decision-making units (DMUs) must be at least twice the total number of input and output indicators.

Based on these four criteria, listed companies classified under "Transportation, Storage, and Postal Services" are screened, resulting in a final sample of 50 listed logistics companies.All firm-level operational data used in this study are obtained from the China Stock Market & Accounting Research (CSMAR) database, which ensures data authenticity and reliability.The basic information of the 50 listed logistics companies is presented in Table 2.

Table 2. Sample of Listed Logistics Companies in China

	Name			Name
1	Yantian Port		26	Jiangxi Ganyue Expressway
2	Shenzhen Airport		27	Shandong Hi-Speed Group
3	CITIC OFFSHORE HELICOPTER		28	Guangxi Wuzhou Communications
4	Guangdong Provincial Expressway Development		29	Jiangsu Expressway
5	Port of Zhuhai		30	Shenzhen Expressway
6	Hunan Investment Group		31	Jiangxi Changyun
7	Beibu Gulf Port		32	Dazhong Transportation Group
8	Dongguan Development (Holdings)		33	Shanghai Jiao Yun Group
9	Modern Portfolio Theory		34	Tianjin Port
10	China Merchants Port Group		35	CMST Development
11	Port of Nanjing		36	Zhangjiagang Freetrade Science & Technology Group
12	Hainan Strait Shipping		37	Ningbo Marine Company Limited
13	Sichuan Fulin Transportation Group		38	Shanghai Shentong Metro
14	Zhuhai Winbase International Chemical Tank Terminal		39	Xiamen International Airport
15	Guangzhou Baiyun International Airport		40	Tangshan Port
16	Shanghai Airport		41	Daqin Railway
17	Anhui Expressway Company Limited		42	Lianyungang
18	Rizhao Port		43	Ningbo Port
19	Shanghai International Port		44	Sichuan Expressway Company Limited
20	Henan Zhongyuan Expressway		45	Air China Limited
21	China Southern Airlines		46	Heilongjiang Transport Development
22	Fujian Expressway Development		47	Guangshen Railway
23	Hubei Chutian Smart Communication		48	Jilin Expressway
24	Chongqing Road & Bridge		49	China Merchants Energy Shipping
25	China Railway Tielong Container Logistics		50	Bohai Ferry Group

2.4. Sample Analysis

(1)Industry Classification

The sampled logistics enterprises exhibit notable differences in their distribution across sub-sectors, as illustrated in Fig. 1. According to China's secondary classification standards for the logistics industry, 21 firms belong to the road transportation sub-sector, accounting for 42% of the total sample. Water transportation enterprises constitute the second-largest group, with 14 firms representing 28% of the sample. Air transportation and railway transportation enterprises rank jointly third, with six firms each, accounting for approximately 12% of the total sample, respectively. In contrast, warehousing enterprises are relatively underrepresented, with only three firms, accounting for 6% of the sample.

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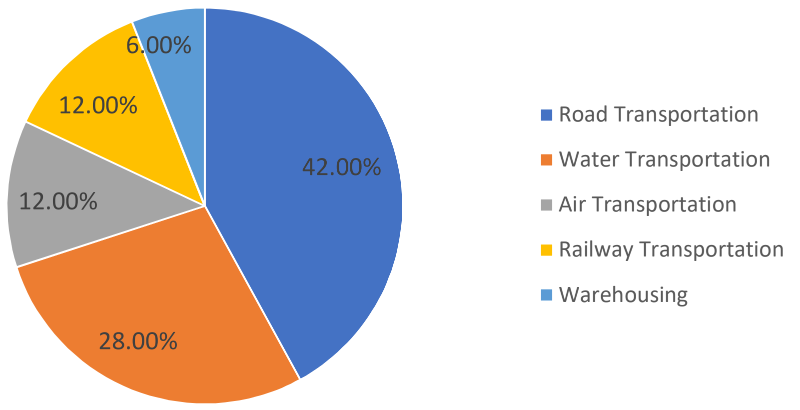

Fig. 1 Industry Distribution of Sampled Logistics Enterprises

(2)Regional Distribution

The sampled logistics enterprises cover 31 provinces and municipalities across China, exhibiting pronounced regional disparities in their distribution.The eastern region hosts 37 enterprises, accounting for 74% of the total sample, which is well above half of the overall sample size.The central region includes 10 enterprises (20%), while the western region contains only 3 enterprises (6%). A further breakdown indicates that logistics enterprises in the eastern region are diversified across sub-sectors, including 14 water transportation firms, 11 road transportation firms, 6 air transportation firms, and 3 firms each in railway transportation and warehousing, accounting for 37.84%, 29.73%, 16.33%, and 8.11%, respectively.In contrast, logistics enterprises in the central and western regions are predominantly concentrated in road and railway transportation.Specifically, in the central region, there are 8 road transportation enterprises and 2 railway transportation enterprises, accounting for 80% and 20%, respectively.In the western region, 2 enterprises operate in road transportation and 1 in railway transportation, representing 66.67% and 33.33% of the regional sample, respectively.Fig. 2 illustrates the regional distribution of the sampled enterprises across China, while Fig. 3, 4, and 5 present the industry distributions of sampled enterprises in the eastern, central, and western regions, respectively.

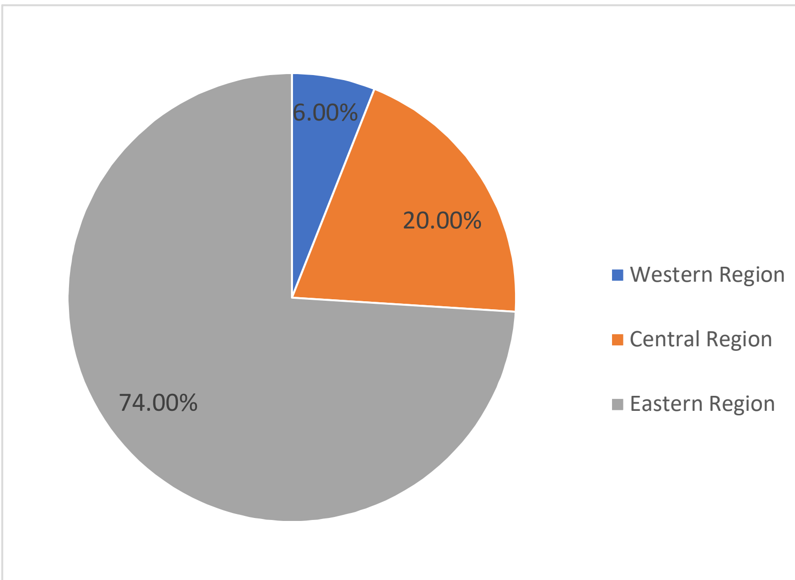

Fig. 2 Regional Distribution of Sampled Logistics Enterprises

ISSN: 2692-7608
DOI: 10.6981/FEM.202603_7(3).0010

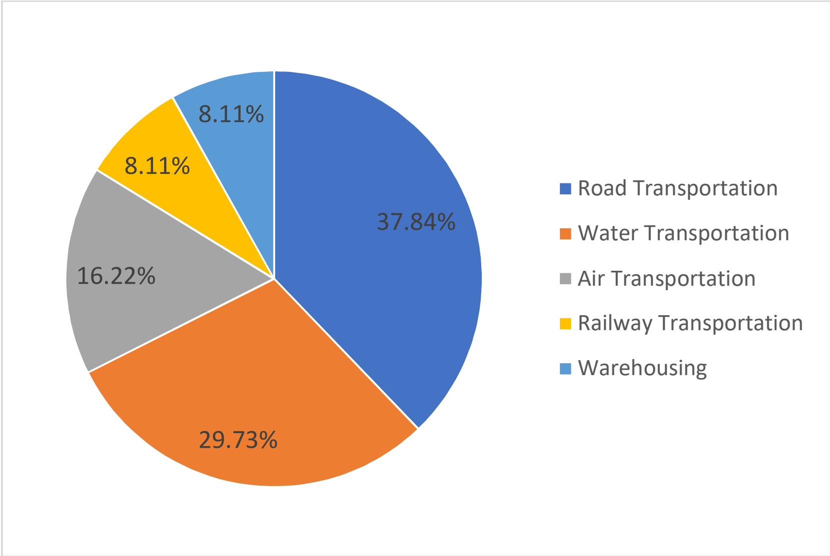

Fig. 3 Industry Distribution of Sampled Logistics Enterprises in the Eastern Region

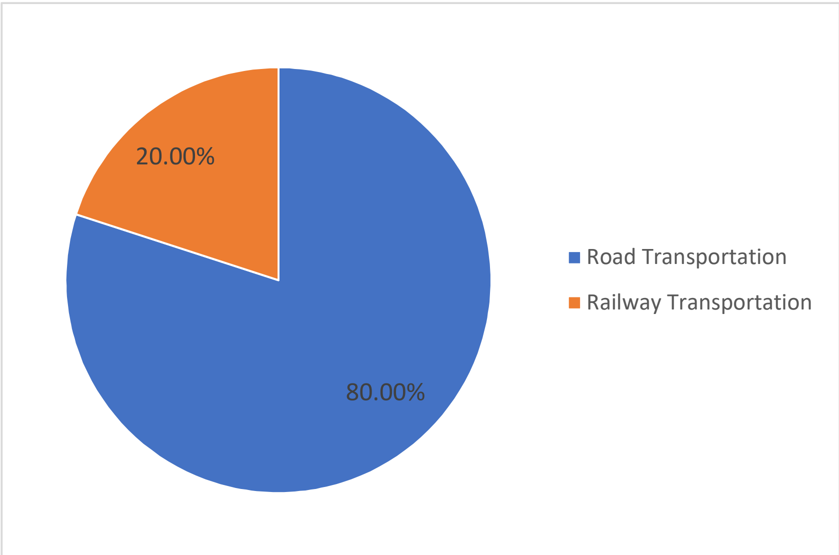

Fig. 4 Industry Distribution of Sampled Logistics Enterprises in the Central Region

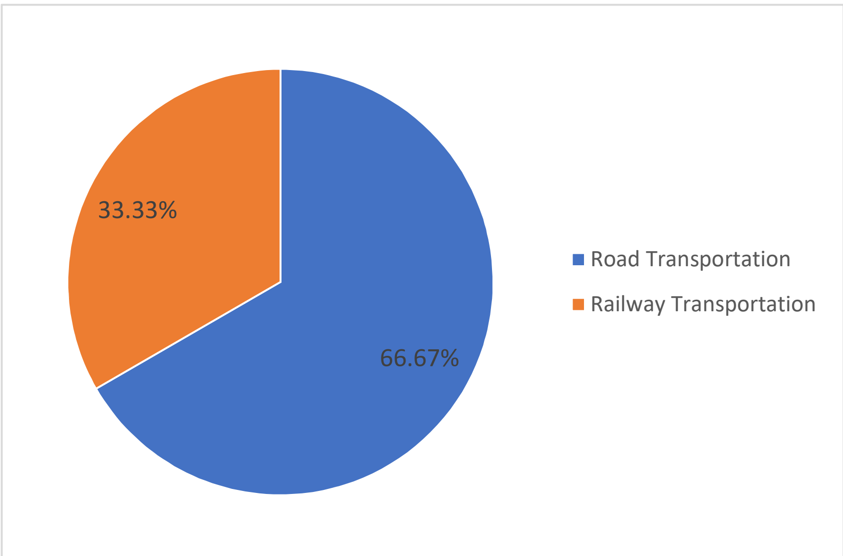

Fig. 5 Industry Distribution of Sampled Logistics Enterprises in the Western Region

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

3. Empirical Results and Analysis

3.1. Static Efficiency Analysis of Listed Logistics Companies based on the DEA-BCC Model

This study employs DEAP 2.1 software to analyze the static operational efficiency of listed logistics companies over the period 2014–2023. The DEA-BCC model is applied to evaluate comprehensive (overall) efficiency, pure technical efficiency, and scale efficiency across the ten-year study period.

3.1.1. Analysis of Overall Efficiency

Based on the ten-year input–output data of 50 listed logistics companies in China from 2014 to 2023, an analysis of overall efficiency is conducted to examine the proportional relationship between actual output and the maximum attainable output level of enterprises.An overall efficiency value of 1 indicates that a firm is DEA-efficient and operates on the efficient production frontier, whereas a value below 1 suggests DEA inefficiency, implying that the firm operates outside the production frontier.In such cases, logistics enterprises may improve their overall efficiency by enhancing technological and managerial capabilities and optimizing their operational scale.

(1) Firm-Level Analysis

Table 3. Overall Efficiency Scores of 50 Listed Logistics Companies in China (2014–2023)

DMU	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
Yantian Port	0.79	0.966	0.702	0.692	0.637	0.765	0.86	0.911	0.849	0.937	0.811
Shenzhen Airport	0.78	0.854	0.813	0.825	0.803	0.834	0.773	0.663	0.616	0.769	0.773
CITIC OFFSHORE HELICOPTER	0.808	0.84	0.8	0.78	0.795	0.811	0.937	0.915	0.861	0.858	0.841
Guangdong Provincial Expressway Development	0.791	0.79	0.89	1	1	0.953	1	1	1	1	0.942
Port of Zhuhai	0.824	0.838	0.861	0.879	0.865	0.844	0.827	0.78	0.802	0.763	0.828
Hunan Investment Group	0.748	0.834	0.804	1	0.816	0.812	0.95	0.956	0.949	0.999	0.887
Beibu Gulf Port	0.962	0.82	0.851	0.896	0.87	0.961	0.982	0.728	0.961	0.924	0.896
Dongguan Development (Holdings)	1	1	1	1	0.864	0.913	1	1	0.956	0.872	0.961
Modern Portfolio Theory	0.794	0.842	0.893	0.883	0.877	0.804	0.846	0.751	0.847	0.721	0.826
China Merchants Port Group	0.876	1	1	1	0.814	1	0.869	0.77	0.851	0.805	0.899
Port of Nanjing	0.861	1	0.662	0.827	0.858	0.911	1	1	1	0.965	0.908
Hainan Strait Shipping	0.792	0.936	0.93	0.884	0.868	0.853	0.971	0.873	1	1	0.911
Sichuan Fulin Transportation Group	0.949	1	1	1	1	1	1	1	1	1	0.995
Zhuhai Winbase International Chemical Tank Terminal	0.823	0.99	0.86	1	0.841	1	1	1	1	1	0.951
Guangzhou Baiyun International Airport	0.981	1	1	0.978	0.91	0.955	0.709	0.629	0.583	0.811	0.856
Shanghai Airport	0.956	1	1	1	1	1	0.501	0.401	0.395	0.639	0.789
Anhui Expressway Company Limited	1	1	0.905	0.951	0.94	0.944	0.993	1	0.991	0.985	0.971
Rizhao Port	0.88	0.775	0.736	0.802	0.852	0.863	0.954	0.898	0.997	0.965	0.872
Shanghai International Port	0.901	0.882	0.84	0.842	0.805	0.817	0.876	0.79	0.868	0.787	0.841
Henan Zhongyuan Expressway	1	1	0.987	1	0.954	0.976	0.885	0.861	0.902	0.844	0.941
China Southern Airlines	0.974	1	1	1	1	1	0.815	0.755	0.725	1	0.927

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Fujian Expressway Development	1	1	1	1	1	0.994	1	1	1	1	0.999
Hubei Chutian Smart Communication	0.858	1	0.963	0.912	0.907	0.888	0.949	0.905	0.918	0.938	0.924
Chongqing Road & Bridge	0.779	0.827	0.686	0.794	0.649	0.712	1	1	1	1	0.845
China Railway Tielong Container Logistics	1	1	1	1	1	1	1	1	0.991	1	0.999
Jiangxi Ganyue Expressway	0.774	0.76	0.756	0.761	0.73	0.736	0.803	0.798	0.828	0.791	0.774
Shandong Hi-Speed Group	1	1	0.974	1	0.944	0.941	0.855	0.838	0.879	0.79	0.922
Guangxi Wuzhou Communications	0.775	0.833	0.899	0.835	0.786	0.845	0.943	0.934	0.958	1	0.881
Jiangsu Expressway	1	1	1	1	1	1	1	1	1	1	1.000
Shenzhen Expressway	1	0.93	0.817	0.844	1	0.805	0.868	0.749	0.818	0.864	0.870
Jiangxi Changyun	0.859	0.818	0.847	0.846	0.838	0.811	0.803	0.803	0.79	0.846	0.826
Dazhong Transportation Group	0.728	0.721	0.763	0.69	0.769	0.784	0.767	0.705	0.649	0.738	0.731
Shanghai Jiao Yun Group	0.966	0.96	0.953	0.954	0.933	0.915	0.881	0.883	0.85	0.818	0.911
Tianjin Port	0.904	0.867	0.944	0.902	0.867	0.889	0.929	0.852	0.939	0.835	0.893
CMST Development	1	0.906	0.894	1	0.96	1	1	1	1	1	0.976
Zhangjiagang Freetrade Science & Technology Group	0.826	0.779	0.823	0.828	0.838	0.962	0.987	0.922	0.945	0.954	0.886
Ningbo Marine Company Limited	0.843	0.879	0.842	1	0.921	0.924	0.951	0.955	0.976	0.901	0.919
Shanghai Shentong Metro	1	1	1	1	0.824	0.822	1	0.968	1	1	0.961
Xiamen International Airport	1	1	1	1	1	1	0.935	0.906	0.852	0.964	0.966
Tangshan Port	0.914	0.942	0.905	0.902	0.897	0.922	0.96	0.803	0.889	0.864	0.900
Daqin Railway	1	1	1	1	1	1	1	1	1	1	1.000
Lianyungang	0.764	0.822	0.792	0.782	0.711	0.727	0.811	0.751	0.828	0.743	0.773
Ningbo Port	0.837	0.833	0.82	0.858	0.829	0.897	0.906	0.751	0.859	0.823	0.841
Sichuan Expressway Company Limited	0.884	0.836	0.778	0.806	0.764	0.784	0.831	0.796	0.926	0.982	0.839
Air China Limited	1	1	1	1	1	1	0.851	0.67	0.579	0.929	0.903
Heilongjiang Transport Development	0.772	0.859	0.745	0.905	0.758	0.84	0.915	0.921	0.901	0.887	0.850
Guangshen Railway	0.872	0.867	1	1	0.927	0.906	0.818	0.833	0.835	1	0.906
Jilin Expressway	0.893	0.81	0.777	0.946	0.843	0.827	0.857	0.9	1	1	0.885
China Merchants Energy Shipping	0.601	0.9	0.789	0.676	0.739	0.814	0.93	0.832	0.961	0.96	0.820
Bohai Ferry Group	0.932	0.966	0.96	0.942	0.892	0.898	0.967	1	1	1	0.956
Mean	0.885	0.910	0.885	0.908	0.874	0.893	0.905	0.863	0.886	0.905	0.892

As shown in Table 3, the average overall efficiency of the 50 listed logistics companies during the period 2014–2023 is 0.892, indicating a potential improvement margin of 10.8%. The overall efficiency levels vary considerably across firms, exhibiting substantial dispersion and fluctuation.Notably, two firms-Daqin Railway and Jiangsu–Shanghai Expressway-achieved an overall efficiency score of 1 throughout the ten-year period, indicating that their input–output configurations were DEA-efficient and consistently operated on the optimal production frontier.In contrast, 23 enterprises, including Yantian Port, Hunan Investment, Modern Investment, Chongqing Road & Bridge, and Gan-Yue Expressway, recorded average overall efficiency scores below 0.892, accounting for nearly half of the sample. This finding highlights substantial disparities in overall efficiency among China's listed logistics companies and suggests considerable room for improvement.Firms that fail to reach DEA efficiency may

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

therefore use Daqin Railway and Jiangsu–Shanghai Expressway as benchmark enterprises and adjust their input–output structures accordingly to enhance overall efficiency.

(2) Regional-Level Analysis

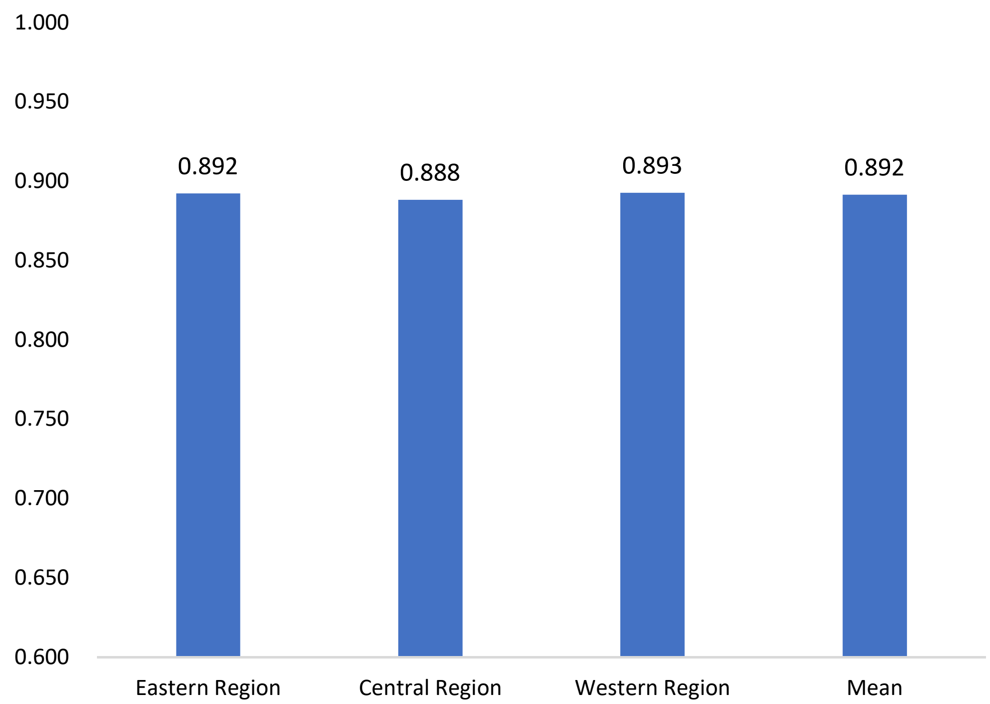

Fig. 6 Average Overall Efficiency of Listed Logistics Companies Across Different Regions in China (2014–2023)

From a regional perspective, the average overall efficiency values of listed logistics companies in the eastern, central, and western regions are 0.892, 0.888, and 0.893, respectively. Notably, the western region exhibits a slightly higher average overall efficiency than both the eastern and central regions.This outcome can be largely attributed to sustained investments in human, financial, and material resources under the Western Development Strategy, which has significantly promoted economic growth in the western region in recent years. It is also related to the large number of logistics enterprises in the eastern region, where uneven development levels among firms tend to lower the regional average efficiency.

3.1.2. Analysis of Pure Technical Efficiency

To further examine the sources of efficiency among listed logistics companies, overall efficiency is decomposed into pure technical efficiency and scale efficiency.Pure technical efficiency focuses on how factors such as technology, management, and institutional arrangements affect overall efficiency, independent of scale effects.When a logistics company's pure technical efficiency score is less than 1, it indicates inefficiency in pure technical terms, which can be improved through enhancements in technological capabilities, managerial practices, and institutional frameworks.Conversely, a pure technical efficiency score of 1 indicates that the firm has achieved pure technical efficiency.

(1) Firm-Level Analysis

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Table 4. Pure Technical Efficiency Scores of 50 Listed Logistics Companies in China (2014–2023)

DMU	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
Yantian Port	1	1	1	1	1	1	0.916	0.997	0.874	1	0.979
Shenzhen Airport	0.801	0.929	0.847	0.858	0.833	0.843	0.776	0.671	0.626	0.797	0.798
CITIC OFFSHORE HELICOPTER	0.85	0.908	0.845	0.841	0.856	0.87	0.938	0.916	0.862	0.866	0.875
Guangdong Provincial Expressway Development	0.824	0.834	0.95	1	1	1	1	1	1	1	0.961
Port of Zhuhai	0.844	0.879	0.88	0.897	0.89	0.855	0.829	0.784	0.802	0.77	0.843
Hunan Investment Group	1	1	1	1	1	1	0.95	0.959	0.95	1	0.986
Beibu Gulf Port	0.967	0.831	0.861	0.903	0.879	0.967	0.987	0.734	1	0.955	0.908
Dongguan Development (Holdings)	1	1	1	1	1	1	1	1	0.957	0.901	0.986
Modern Portfolio Theory	0.805	0.848	0.902	0.883	0.88	0.805	0.887	0.824	0.873	0.75	0.846
China Merchants Port Group	0.945	1	1	1	0.815	1	1	1	1	1	0.976
Port of Nanjing	1	1	0.999	0.946	1	1	1	1	1	0.977	0.992
Hainan Strait Shipping	0.901	0.966	0.999	0.975	0.955	0.937	0.971	0.877	1	1	0.958
Sichuan Fulin Transportation Group	1	1	1	1	1	1	1	1	1	1	1.000
Zhuhai Winbase International Chemical Tank Terminal	1	1	1	1	1	1	1	1	1	1	1.000
Guangzhou Baiyun International Airport	1	1	1	0.98	0.918	0.96	0.71	0.632	0.585	0.823	0.861
Shanghai Airport	0.957	1	1	1	1	1	0.507	0.413	0.397	0.73	0.800
Anhui Expressway Company Limited	1	1	0.996	1	1	0.971	1	1	0.992	0.988	0.995
Rizhao Port	0.884	0.784	0.748	0.812	0.87	0.869	0.977	0.928	1	0.966	0.884
Shanghai International Port	0.942	1	1	1	1	1	1	1	1	1	0.994
Henan Zhongyuan Expressway	1	1	1	1	1	1	0.891	0.862	0.905	0.855	0.951
China Southern Airlines	1	1	1	1	1	1	1	1	1	1	1.000
Fujian Expressway Development	1	1	1	1	1	1	1	1	1	1	1.000
Hubei Chutian Smart Communication	0.989	1	1	0.926	0.927	0.898	0.952	0.909	0.919	0.939	0.946
Chongqing Road & Bridge	1	1	1	1	1	1	1	1	1	1	1.000
China Railway Tielong Container Logistics	1	1	1	1	1	1	1	1	0.992	1	0.999
Jiangxi Ganyue Expressway	0.777	0.771	0.756	0.808	0.776	0.763	0.805	0.798	0.839	0.81	0.790
Shandong Hi-Speed Group	1	1	0.98	1	0.947	0.958	0.956	1	1	0.982	0.982

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Guangxi Wuzhou Communications	0.791	0.86	1	0.955	0.927	0.911	0.957	0.934	0.958	1	0.929
Jiangsu Expressway	1	1	1	1	1	1	1	1	1	1	1.000
Shenzhen Expressway	1	0.956	0.82	0.886	1	0.83	0.924	0.889	0.891	0.903	0.910
Jiangxi Changyun	0.899	0.851	0.858	0.855	0.867	0.84	0.807	0.806	0.792	0.864	0.844
Dazhong Transportation Group	0.762	0.743	0.788	0.76	0.811	0.833	0.771	0.715	0.656	0.742	0.758
Shanghai Jiao Yun Group	0.968	0.968	0.958	0.957	0.934	0.917	0.883	0.885	0.85	0.835	0.916
Tianjin Port	0.927	0.915	0.957	0.903	0.871	0.891	0.981	0.934	0.972	0.912	0.926
CMST Development	1	1	1	1	1	1	1	1	1	1	1.000
Zhangjiagang Freetrade Science & Technology Group	0.932	0.893	0.891	0.89	0.909	0.982	0.993	0.923	0.946	0.955	0.931
Ningbo Marine Company Limited	0.877	0.905	0.92	1	0.981	0.969	0.951	0.955	0.978	0.903	0.944
Shanghai Shentong Metro	1	1	1	1	1	0.946	1	0.971	1	1	0.992
Xiamen International Airport	1	1	1	1	1	1	0.936	0.907	0.854	0.965	0.966
Tangshan Port	0.936	0.945	0.908	0.903	0.901	0.924	1	0.805	0.893	0.9	0.912
Daqin Railway	1	1	1	1	1	1	1	1	1	1	1.000
Lianyungang	0.823	0.848	0.85	0.836	0.8	0.812	0.814	0.755	0.83	0.759	0.813
Ningbo Port	0.839	0.875	0.834	0.859	0.863	0.897	1	1	0.957	0.987	0.911
Sichuan Expressway Company Limited	0.893	0.841	0.779	0.807	0.785	0.802	0.851	0.803	0.96	0.999	0.852
Air China Limited	1	1	1	1	1	1	1	0.808	0.599	0.96	0.937
Heilongjiang Transport Development	0.967	0.975	0.968	0.929	0.952	0.973	0.915	0.924	0.901	0.914	0.942
Guangshen Railway	0.872	0.868	1	1	0.937	0.913	0.82	0.834	0.838	1	0.908
Jilin Expressway	1	1	0.996	1	1	0.975	0.862	0.905	1	1	0.974
China Merchants Energy Shipping	0.614	0.909	0.791	0.685	0.741	0.815	0.992	0.943	1	1	0.849
Bohai Ferry Group	0.952	0.989	0.989	0.952	0.917	0.915	0.967	1	1	1	0.968
Mean	0.931	0.942	0.941	0.940	0.935	0.937	0.930	0.900	0.909	0.934	0.930

As shown in Table 4, the average pure technical efficiency of the 50 listed logistics companies over the period 2014–2023 is 0.930.Eight companies—China Southern Airlines, Fulin Transport, Hengji Dacheng, Fujian Expressway, Jiangsu–Shanghai Expressway, China National Storage & Transportation, Chongqing Road & Bridge, and Daqin Railway—achieved the optimal pure technical efficiency score of 1 throughout the ten-year period.By contrast, 21 enterprises, including Wuzhou Transportation, Tianjin Port, Jiaoyun Co., and Dazhong Transportation, recorded average pure technical efficiency scores below 0.930. Among them, only 13 firms exhibited pure technical efficiency scores below 0.9, indicating that the majority of listed logistics companies maintain relatively strong managerial and technical performance.

Regional-Level Analysis

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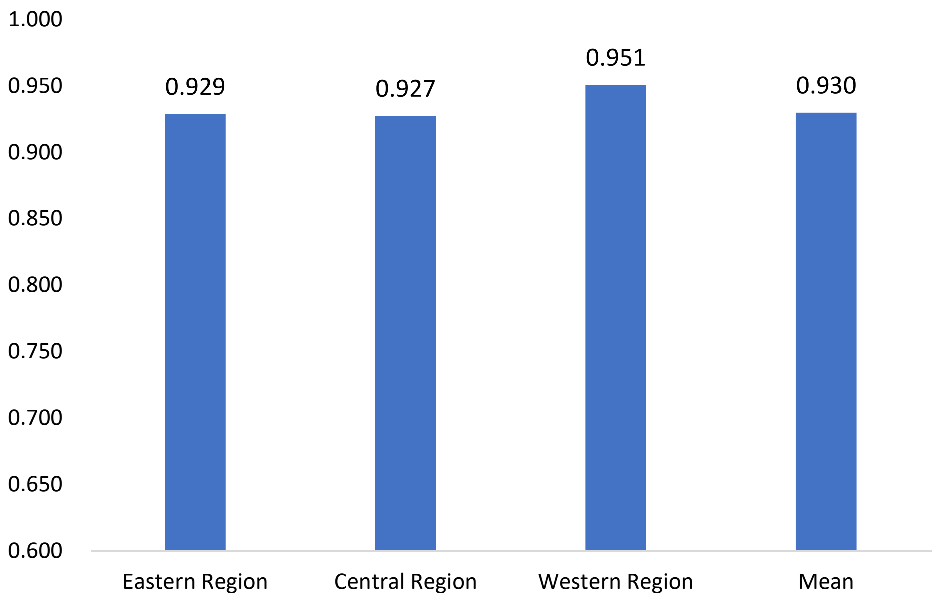

Fig. 7 Average Pure Technical Efficiency of Listed Logistics Companies Across Different Regions in China (2014–2023)

From a regional perspective, the average pure technical efficiency of listed logistics companies in the eastern, central, and western regions is 0.929, 0.927, and 0.951, respectively, with the western region exhibiting a higher average level than both the eastern and central regions.This pattern is consistent with the regional differences observed in overall efficiency. Moreover, the extensive coverage but uneven development of the logistics industry in the eastern region-particularly the relatively low efficiency of water and air transportation sectors-contributes to a lower regional average.

3.1.3. Analysis of Scale Efficiency

Scale efficiency reflects the degree of alignment between a firm's input–output scale and the optimal scale of production.When the input–output scale reaches the optimal level, the firm achieves scale efficiency; otherwise, adjustments to input and output levels are required to improve scale efficiency.

(1) Firm-Level Analysis

Table 5. Scale Efficiency Scores of 50 Listed Logistics Companies in China (2014–2023)

DMU	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
Yantian Port	0.79	0.966	0.702	0.692	0.637	0.765	0.939	0.914	0.972	0.937	0.831
Shenzhen Airport	0.974	0.92	0.96	0.962	0.964	0.989	0.996	0.988	0.984	0.965	0.970
CITIC OFFSHORE HELICOPTER	0.951	0.925	0.948	0.928	0.929	0.932	0.999	0.998	0.999	0.991	0.960
Guangdong Provincial Expressway Development	0.96	0.947	0.937	1	1	0.953	1	1	1	1	0.980
Port of Zhuhai	0.976	0.954	0.979	0.981	0.972	0.987	0.997	0.995	0.999	0.99	0.983
Hunan Investment Group	0.748	0.834	0.804	1	0.816	0.812	0.999	0.997	0.998	0.999	0.901
Beibu Gulf Port	0.995	0.986	0.989	0.992	0.989	0.994	0.995	0.992	0.961	0.967	0.986
Dongguan Development (Holdings)	1	1	1	1	0.864	0.913	1	1	0.999	0.967	0.974

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Modern Portfolio Theory	0.986	0.992	0.99	0.999	0.997	1	0.954	0.911	0.97	0.96	0.976
China Merchants Port Group	0.927	1	1	1	0.998	1	0.869	0.77	0.851	0.805	0.922
Port of Nanjing	0.861	1	0.663	0.874	0.858	0.911	1	1	1	0.988	0.916
Hainan Strait Shipping	0.879	0.968	0.931	0.907	0.909	0.911	1	0.995	1	1	0.950
Sichuan Fulin Transportation Group	0.949	1	1	1	1	1	1	1	1	1	0.995
Zhuhai Winbase International Chemical Tank Terminal	0.823	0.99	0.86	1	0.841	1	1	1	1	1	0.951
Guangzhou Baiyun International Airport	0.981	1	1	0.998	0.992	0.995	0.999	0.995	0.997	0.984	0.994
Shanghai Airport	0.999	1	1	1	1	1	0.988	0.971	0.996	0.876	0.983
Anhui Expressway Company Limited	1	1	0.908	0.951	0.94	0.972	0.993	1	1	0.997	0.976
Rizhao Port	0.996	0.988	0.984	0.988	0.98	0.993	0.976	0.968	0.997	1	0.987
Shanghai International Port	0.956	0.882	0.84	0.842	0.805	0.817	0.876	0.79	0.868	0.787	0.846
Henan Zhongyuan Expressway	1	1	0.987	1	0.954	0.976	0.994	0.998	0.997	0.987	0.989
China Southern Airlines	0.974	1	1	1	1	1	0.815	0.755	0.725	1	0.927
Fujian Expressway Development	1	1	1	1	1	0.994	1	1	1	1	0.999
Hubei Chutian Smart Communication	0.868	1	0.963	0.985	0.978	0.989	0.997	0.996	0.998	0.999	0.977
Chongqing Road & Bridge	0.779	0.827	0.686	0.794	0.649	0.712	1	1	1	1	0.845
China Railway Tielong Container Logistics	1	1	1	1	1	1	1	1	1	1	1.000
Jiangxi Ganyue Expressway	0.996	0.987	0.999	0.942	0.941	0.964	0.998	0.999	0.988	0.976	0.979
Shandong Hi-Speed Group	1	1	0.994	1	0.996	0.982	0.895	0.838	0.879	0.804	0.939
Guangxi Wuzhou Communications	0.98	0.968	0.899	0.874	0.848	0.927	0.986	1	1	1	0.948
Jiangsu Expressway	1	1	1	1	1	1	1	1	1	1	1.000
Shenzhen Expressway	1	0.974	0.996	0.953	1	0.97	0.939	0.843	0.918	0.958	0.955
Jiangxi Changyun	0.956	0.961	0.988	0.989	0.966	0.965	0.994	0.997	0.998	0.979	0.979
Dazhong Transportation Group	0.956	0.971	0.968	0.908	0.948	0.942	0.995	0.986	0.99	0.995	0.966
Shanghai Jiao Yun Group	0.998	0.991	0.995	0.996	0.999	0.998	0.998	0.997	0.999	0.979	0.995
Tianjin Port	0.975	0.947	0.986	0.999	0.996	0.998	0.947	0.912	0.966	0.915	0.964
CMST Development	1	0.906	0.894	1	0.96	1	1	1	1	1	0.976
Zhangjiagang Freetrade Science & Technology Group	0.887	0.872	0.924	0.931	0.921	0.98	0.994	0.999	1	0.998	0.951
Ningbo Marine Company Limited	0.961	0.972	0.915	1	0.938	0.954	1	1	0.999	0.998	0.974
Shanghai Shentong Metro	1	1	1	1	0.824	0.869	1	0.997	1	1	0.969

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Xiamen International Airport	1	1	1	1	1	1	0.999	0.998	0.998	0.998	0.999
Tangshan Port	0.977	0.998	0.996	0.999	0.996	0.998	0.96	0.997	0.995	0.96	0.988
Daqin Railway	1	1	1	1	1	1	1	1	1	1	1.000
Lianyungang	0.928	0.969	0.932	0.936	0.888	0.896	0.996	0.995	0.999	0.979	0.952
Ningbo Port	0.998	0.952	0.983	0.998	0.96	1	0.906	0.751	0.898	0.834	0.928
Sichuan Expressway Company Limited	0.989	0.994	0.999	0.999	0.973	0.977	0.976	0.992	0.965	0.983	0.985
Air China Limited	1	1	1	1	1	1	0.851	0.83	0.966	0.968	0.962
Heilongjiang Transport Development	0.798	0.881	0.77	0.974	0.796	0.864	1	0.997	0.999	0.97	0.905
Guangshen Railway	1	0.998	1	1	0.989	0.992	0.998	0.998	0.996	1	0.997
Jilin Expressway	0.893	0.81	0.78	0.946	0.843	0.848	0.994	0.994	1	1	0.911
China Merchants Energy Shipping	0.98	0.991	0.997	0.988	0.998	1	0.937	0.882	0.961	0.96	0.969
Bohai Ferry Group	0.979	0.977	0.971	0.99	0.972	0.981	1	1	1	1	0.987
Mean	0.952	0.966	0.942	0.966	0.936	0.954	0.975	0.961	0.977	0.969	0.960

As indicated in Table 5, the average scale efficiency of the 50 listed logistics companies during the period 2014–2023 is 0.960. Among them, three companies—Tielong Logistics, Jiangsu–Shanghai Expressway, and Daqin Railway—achieved a scale efficiency score of 1 throughout the ten-year period.A total of 33 listed logistics companies recorded scale efficiency scores above 0.960, accounting for 65% of the sample. This indicates that most logistics enterprises have achieved economies of scale and maintain relatively strong operational and managerial performance.

(2) Regional-Level Analysis

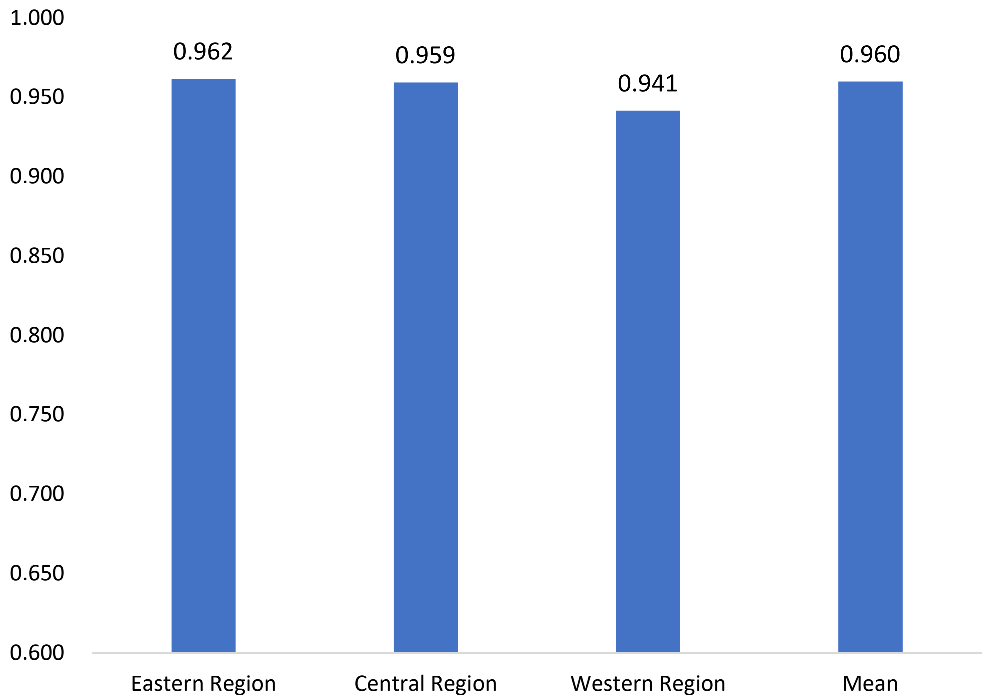

Fig. 8 Average Scale Efficiency of Listed Logistics Companies Across Different Regions in China (2014–2023)

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

From a regional perspective, the average scale efficiency of listed logistics companies in the eastern, central, and western regions is 0.962, 0.959, and 0.941, respectively, with the eastern region exhibiting a higher average level than both the central and western regions.This pattern differs from the regional disparities observed in overall efficiency and pure technical efficiency.As discussed above, the eastern region hosts a large number of logistics enterprises, which facilitates scale formation and enables firms to achieve superior scale economies, accompanied by relatively strong operational and managerial performance.

3.2. Dynamic Efficiency Analysis of Listed Logistics Companies based on the Malmquist Index

Static analysis focuses primarily on the efficiency performance of listed logistics companies in individual years and therefore cannot fully capture the dynamic evolution of logistics efficiency over time.To address this limitation, this study employs the Malmquist productivity index to dynamically analyze changes in total factor productivity (TFP), technical efficiency, and technological progress for 50 listed logistics companies in China over the period 2014–2023. Furthermore, year-by-year and firm-level analyses of TFP changes are conducted to reveal the dynamic evolution of efficiency in the logistics sector.

Table 6. Annual Changes and Decomposition of the Malmquist Index for 50 Listed Logistics Companies in China (2014–2023)

Year	effch	techch	pech	sech	tfp
2014-2015	1.037	1.101	1.012	1.025	1.145
2015-2016	0.993	1.115	1.001	0.991	1.114
2016-2017	0.995	1.160	0.995	1.002	1.149
2017-2018	0.993	0.826	1.005	0.988	0.823
2018-2019	1.043	1.166	0.999	1.045	1.249
2019-2020	0.986	3.483	1.005	0.978	3.564
2020-2021	0.982	1.059	0.974	1.011	1.035
2021-2022	1.018	1.172	1.005	1.014	1.194
2022-2023	1.002	0.634	1.048	0.973	0.639
Mean	1.005	1.302	1.005	1.003	1.324

Note: effch denotes the technical efficiency change index; techch represents the technological progress index; pech refers to the pure technical efficiency change index; sech indicates the scale efficiency change index; and tfp denotes the total factor productivity index.

As shown in Table 6, the average total factor productivity (TFP) index over the period 2014–2023 is 1.324. Only the periods 2017–2018 and 2022–2023 record TFP values below 1, while the TFP index reaches as high as 3.564 in 2019–2020. These results indicate that the overall TFP performance of China's listed logistics companies has been relatively strong over the ten-year period, albeit with considerable fluctuations.By decomposing total factor productivity into technical efficiency change (effch) and technological progress (techch), the analysis reveals that the average values of effch and techch over the ten-year period are 1.005 and 1.302, respectively, both exceeding 1. This suggests that improvements in technical efficiency and technological progress jointly contributed to the growth of total factor productivity among listed logistics companies.

Regarding technical efficiency changes, the analysis shows that technical efficiency fluctuated slightly over the ten-year period from 2014 to 2023, with relatively small variations. This

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

indicates that the level of technological advancement has a significant impact on the operational efficiency of the logistics industry in China.The lowest technical efficiency occurred in 2020–2021, with a value of 0.982. This decline can be attributed to a lower pure technical efficiency index during this period, suggesting that there is still significant potential for technological improvement in China's logistics industry during 2020–2021.

From the perspective of the technological progress index, the index was below 1 only during the periods 2017–2018 and 2022–2023, with the highest value of 3.483 recorded in 2019–2020. This pattern aligns closely with the overall fluctuations observed in total factor productivity (TFP), indicating that the TFP growth of China's listed logistics companies during 2014–2023 was mainly driven by technological progress.In 2019–2020, the average technological progress index for the 50 listed logistics companies was 3.483, reflecting significant technological advancements in China's logistics sector during this year. Conversely, in 2022–2023, the average technological progress index for the 50 listed logistics companies dropped to 0.634, representing a 45.9% decline compared to 2021–2022, indicating a regression in technological development during that period.

Table 7. Annual Changes and Decomposition of the Malmquist Index for 50 Listed Logistics Companies in China (2014–2023)

		effch	techch	pech	sech	tfp
000088	Yantian Port	1.000	1.265	1.000	1.000	1.313
000429	Guangdong Provincial Expressway Development	1.017	1.281	1.015	1.000	1.246
000548	Hunan Investment Group	0.980	1.104	1.000	0.980	2.963
000828	Dongguan Development (Holdings)	1.007	1.404	1.000	1.007	1.265
000900	Modern Portfolio Theory	1.000	1.246	1.000	1.000	1.096
002357	Sichuan Fulin Transportation Group	1.000	1.418	1.000	1.000	1.545
600012	Anhui Expressway Company Limited	0.989	1.274	0.996	0.999	1.315
600020	Henan Zhongyuan Expressway	0.993	1.116	0.999	0.993	1.107
600033	Fujian Expressway Development	0.985	1.034	1.000	0.985	1.374
600035	Hubei Chutian Smart Communication	0.993	1.371	0.995	0.998	1.377
600106	Chongqing Road & Bridge	1.000	1.374	1.000	1.000	1.490
600269	Jiangxi Ganyue Expressway	1.000	1.490	1.000	1.000	1.102
600350	Shandong Hi-Speed Group	1.000	1.276	1.000	1.000	1.020
600368	Guangxi Wuzhou Communications	1.000	1.207	1.000	1.000	1.352
600377	Jiangsu Expressway	1.035	1.308	1.033	1.005	1.114
600548	Shenzhen Expressway	0.985	1.194	0.990	0.995	1.087
600561	Jiangxi Changyun	1.005	1.541	1.000	1.005	1.624
600611	Dazhong Transportation Group	1.020	1.153	1.031	0.990	1.145
600676	Shanghai Jiao Yun Group	0.992	1.098	1.000	0.992	1.167
600834	Shanghai Shentong Metro	1.002	1.320	1.002	1.000	1.884
601518	Jilin Expressway	1.002	1.223	1.000	1.002	1.429
	Road Transportation	1.000	1.271	1.003	0.998	1.382

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

000507	Port of Zhuhai	1.225	2.464	1.000	1.225	1.230
000582	Beibu Gulf Port	0.995	1.251	1.001	0.994	1.234
001872	China Merchants Port Group	0.941	1.368	1.100	0.960	1.176
002040	Port of Nanjing	1.002	1.508	1.000	1.002	1.505
002320	Hainan Strait Shipping	1.000	1.545	1.000	1.000	1.421
600017	Rizhao Port	1.008	1.422	1.000	1.008	1.394
600018	Shanghai International Port	0.999	1.029	1.000	0.999	1.025
600717	Tianjin Port	1.000	1.114	1.000	1.000	1.096
600798	Ningbo Marine Company Limited	1.000	1.047	1.000	1.000	1.416
601000	Tangshan Port	1.002	1.126	1.002	1.000	1.127
601008	Lianyungang	1.031	1.365	1.008	1.022	1.364
601018	Ningbo Port	1.014	1.030	1.014	1.002	1.047
601872	China Merchants Energy Shipping	1.001	1.189	1.001	1.000	1.193
603167	Bohai Ferry Group	1.000	1.386	1.000	1.000	2.092
	Water Transportation	1.016	1.346	1.009	1.015	1.308
000089	Shenzhen Airport	1.007	1.463	1.007	1.006	1.298
000099	CITIC OFFSHORE HELICOPTER	1.012	1.217	1.010	1.000	1.476
600004	Guangzhou Baiyun International Airport	1.028	1.306	1.000	1.028	1.193
600009	Shanghai Airport	1.022	1.378	1.012	1.008	1.153
600029	China Southern Airlines	1.006	1.066	1.000	1.006	1.066
600897	Xiamen International Airport	1.003	1.113	1.001	1.001	1.310
	Air Transportation	1.013	1.257	1.005	1.008	1.249
600125	China Railway Tielong Container Logistics	1.009	1.084	1.022	0.988	1.276
601006	Daqin Railway	1.000	1.118	1.000	1.000	1.118
601107	Sichuan Expressway Company Limited	1.003	1.861	1.000	1.003	1.124
601111	Air China Limited	1.023	1.273	1.006	1.016	1.047
601188	Heilongjiang Transport Development	1.000	1.279	1.000	1.000	1.386
601333	Guangshen Railway	1.000	1.429	1.000	1.000	1.224
	Railway Transportation	1.006	1.341	1.005	1.001	1.196
002492	Zhuhai Winbase International Chemical Tank Terminal	0.938	1.353	1.000	0.938	1.418
600787	CMST Development	1.004	1.503	1.003	1.002	1.207
600794	Zhangjiagang Freetrade Science & Technology Group	0.993	1.097	1.001	0.990	1.547
	Warehousing	0.978	1.318	1.001	0.977	1.391
	Mean	1.005	1.302	1.005	1.003	1.324

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

As shown in Table 7, the average values of total factor productivity (TFP), technical efficiency change (effch), and technological progress change (techch) for the period 2014–2023 all exceed 1. This indicates that, over the past decade, overall productivity, technological innovation, and technical efficiency have all experienced positive growth.Except for 12 firms, including Hunan Investment and Beibu Gulf Port, which recorded technical efficiency changes below 1, all other companies exhibited TFP, technological progress, and technical efficiency changes greater than 1. This suggests that despite the relatively slow progress in productivity and technological advancement in certain areas of the logistics industry, most enterprises have achieved significant improvements in productivity and technological innovation.

From an industry perspective, the average total factor productivity for road transportation, water transportation, air transportation, railway transportation, and warehousing enterprises are 1.382, 1.308, 1.249, 1.196, and 1.391, respectively.Notably, water transportation, air transportation, and railway transportation all have average TFP values lower than the national average of 1.324, indicating that the operational performance of these sectors does not yet meet the developmental needs of the logistics industry.

4. Conclusion and Recommendations

4.1. Conclusion

This study, based on the 2021 Q3 Industry Classification Results of Listed Companies issued by the China Securities Regulatory Commission (CSRC), selects 50 listed logistics companies as the research sample. The study employs the DEA model and the Malmquist index method to conduct both static and dynamic efficiency analyses of these companies over the period from 2014 to 2023.Specifically, the DEA model is used to analyze the overall technical efficiency, pure technical efficiency, and scale efficiency of the 50 listed logistics companies, while the Malmquist index method is applied to analyze changes in total factor productivity (TFP), technological progress, and technical efficiency over time. Three main conclusions are drawn from the analysis:

(1) Overall efficiency exhibits minor fluctuations, stabilizing around 0.890

Over the 2014–2023 period, the overall technical efficiency of the 50 listed logistics companies fluctuated around 0.890 with relatively small variations. The average overall efficiency during this period was 0.892, indicating a remaining improvement potential of 10.8%. The fluctuations in scale efficiency were in line with those in overall efficiency, with a notable decline in 2018 primarily caused by a drop in scale efficiency. The most significant decline in pure technical efficiency occurred in 2021, falling from 0.930 to 0.900, leading to a sharp decrease in overall efficiency during that year.This decline can be attributed to the impact of the pandemic from 2019 onward, which led to a shift in logistics demand towards a medium-to-high growth phase. The rapid increase in logistics units and the expansion of firm scale contributed to a significant improvement in scale efficiency.

(2) Total factor productivity (TFP) exhibited an initial increase followed by a decline, with significant fluctuations

The total factor productivity (TFP) index of China's logistics companies initially increased and then declined, with the largest increase occurring in 2019, where the TFP index reached 3.564. The main reason for the increase in TFP was a significant improvement in technological performance.From an industry perspective, warehousing enterprises had the highest TFP index and also showed a relatively high technological progress index, suggesting that TFP was primarily driven by technological advancements.

(3) Development levels vary across regions

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

Regionally, logistics enterprises in the western region have greater development potential. This is reflected in the highest average overall efficiency and pure technical efficiency in this region from 2014 to 2023. These improvements can be attributed to the Chinese government's continued investments in the western region under the Western Development Strategy, which have concentrated enterprise strength and further accelerated economic development in the west.In contrast, logistics enterprises in the eastern region had a higher average scale efficiency, due to the rapid development in this area, where the large number of logistics companies has created significant scale economies.Furthermore, there were significant differences in the TFP index across individual companies, indicating that TFP is influenced by both regional factors and the companies' own management and operational strategies.

4.2. Recommendations

4.2.1. Firm-Level Recommendations

(1) Further strengthen innovation in logistics technology and the application of new technologies.

The dynamic efficiency analysis of logistics companies reveals that the technological progress index is a key driver of efficiency changes. Therefore, Chinese logistics companies should further enhance the application of new technologies.Companies can increase investment in the automation of production processes, such as introducing advanced automated sorting equipment, smart warehouse management systems, and autonomous vehicles, to foster the development of intelligence and automation.

(2) Promote the construction of digital platforms and accelerate digital transformation.

Leveraging big data, artificial intelligence, and the Internet of Things (IoT), logistics companies should build digital platforms to facilitate intelligent management of order processing, transportation scheduling, and warehouse monitoring, thus enhancing supply chain transparency and collaborative efficiency.

(3) Strengthen talent development and management.

Logistics companies should focus on attracting high-quality talent and nurturing employee development. This includes recruiting highly educated professionals, collaborating with universities to develop versatile talents, and strengthening the training of existing employees. Companies should aim to build a core team with solid logistics expertise and enhance employees' sense of belonging.Additionally, companies should improve their compensation systems, provide career insurance and health benefits, and safeguard employees' legal rights.

(4) Improve service quality.

Logistics companies should focus on standardizing and regulating services to offer more precise and efficient services.In addition to managing their core business operations, logistics companies should actively expand value-added services, such as packaging design, inventory management, and supply chain finance, to meet the diverse needs of customers.

4.2.2. Government-Level Recommendations

(1) Improve the legal framework for the logistics industry and strengthen market supervision.

The government should accelerate the formulation and improvement of relevant laws and regulations for the logistics industry, clarify market entry conditions and qualification requirements for logistics enterprises, regulate market competition, and prevent negative scale economies caused by overly small or redundant firms. Additionally, logistics outsourcing and other services should be standardized.Furthermore, market supervision should be enhanced to improve the utilization of fixed assets and reduce unreasonable losses.

(2) Increase policy support from relevant government departments for logistics companies.

ISSN: 2692-7608 DOI: 10.6981/FEM.202603_7(3).0010

Government departments should increase their support for logistics companies, accelerate the process of technological innovation, and improve the technical efficiency of enterprises, thereby enhancing their overall efficiency.Additionally, while increasing the scale of logistics companies, smaller firms should be reduced to minimize the negative impact on economies of scale.

Acknowledgments

This paper was supported by the “National Social Science Foundation of China (Grant No. 23CGL050)”.

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