The Measurement of Logistics Industry Efficiency Based on the Construction of Tobacco Transport Logistics Infrastructure

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With the increasingly fierce market competition, China's tobacco industry has been severely tested. At the same time, according to the latest report of global Logistics Performance Index (LPI), there is a significant difference between China's LPI and other developed countries, indicating that China's logistics has low efficiency, high input and low output. How to improve the service level and operation efficiency of tobacco enterprises by strengthening the construction of logistics infrastructure network is an urgent problem for tobacco enterprises to solve. Therefore, DEA model and Malmquist index model are adopted in this paper to measure the logistics efficiency of Chinese tobacco enterprises from the aspect of logistics infrastructure network construction. This paper analyzes the state of logistics efficiency and the reasons of low efficiency in some economic regions and puts forward countermeasures and suggestions to improve the logistics efficiency of tobacco enterprises based on the construction of logistics infrastructure network.

Key words: tobacco industry; logistics efficiency; logistics infrastructure; network construction
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INTRODUCTION

Logistics construction of tobacco industry runs through the whole tobacco supply chain, which is closely related to production and marketing. Tobacco logistics industry is divided into commercial logistics and industrial logistics. Tobacco industry logistics operation process is long, the process is complex, the formation of "output - supply - sales" three in one industry chain; Operation variety, involving raw materials, tobacco materials, finished products, etc.; The operation area is wide and basically covers the whole country, so it brings the situation of "high complexity and large mining space". Based on this situation, the existing tobacco logistics system are separate tobacco, cigarettes, cigarette material such as logistics, in order to form a "cigarette logistics, tobacco logistics, cigarette materials logistics", etc. Its current situation, in failing to effectively achieve logistics, on the basis of intensive management, professional management, caused the waste of resources. Among them, tobacco materials are auxiliary materials for cigarette production, mainly printed materials, and the current market supply is stable. Tobacco leaf is an important raw material for cigarette production, and it is an agricultural product exclusively managed and sold by the state. The tobacco monopoly bureaux at all levels are the suppliers, and the purchase and distribution are strictly controlled by the state monopoly system. In the face of such a complex system, tobacco enterprises

must rely on process innovation, lean management, information technology and other means to achieve a rapid response to the whole process of raw materials and auxiliary materials supply, which is the guarantee of high-quality development of tobacco industry enterprises logistics.

In China, the economy has changed from a high-speed growth stage to a high-quality development stage. Moreover, the strategic task of supply-side structural reform is put forward to realize "cost reduction and efficiency increase" of the national industry, in which the logistics industry as the "third profit source" is not only the basic industry supporting the national economy, but also an important component of the modern service industry with strategic and leading characteristics to lead the industrial upgrading through supply chain service. Therefore, it is very important to promote the optimization of the overall national economic structure through the high-quality development of the logistics industry and the improvement of logistics efficiency. In 2019, the National Development and Reform Commission and other departments jointly issued the Proposal on Promoting High-quality Development of Logistics and Promoting the Formation of a Strong Domestic Market. However, it is a long way to go to achieve high-quality development of the logistics industry to improve logistics efficiency and achieve cost reduction and efficiency increase. China's logistics industry, which is expanding rapidly in scale and speed, still has the problems of high input and low output.

The construction of logistics infrastructure, as the content of logistics infrastructure, has become an important part of improving China's logistics performance index. However, from the overall macro perspective, a large amount of investment in the construction of logistics infrastructure has not been matched by high-quality and high-output logistics. As a result, the construction of logistics infrastructure has received extensive attention from the country and society in recent years. For this reason, the second part of Suggestions on Promoting the Development of High-quality Logistics and Forming a Strong Domestic Market puts forward the overall proposal of "Building a High-quality Logistics Infrastructure Network System". Thus, it is obvious that improving the construction of logistics infrastructure network will play a certain role in improving logistics efficiency.

LITERATURE REVIEW

Kaufman Annette (2021) analyzed the diversity of tobacco product advertising, marketing and other communication through the exposition of eye movement tracking method and its application in tobacco regulatory science[1]. Higgins Stephen T. (2020) proposed some current challenges in the science of tobacco control and regulation by analyzing the impact of tobacco on behavioral change, health and health differences[2]. Andda Leda Ramos (2016) used the balanced scorecard system in combination with various models to measure the logistics efficiency of many enterprises, and made comparative analysis, and finally obtained the common factors affecting enterprise logistics[3]. HokeyM in (2013) evaluated the efficiency of 24 third-party logistics enterprises from North America, and concluded that a large part of the leading third-party logistics enterprises are inevitably faced with the problems of low utilization rate of logistics resources and overcapacity[4].

Rabinovich et al. (2006) used DEA model to study the logistics efficiency of American logistics enterprises, and discussed the relationship among service breadth, service performance and production efficiency[5]. Wu Huaqing (2012) and others used DEA model to evaluate and analyze the efficiency of China's reverse logistics channel management[6]. Hao Rong (2015) also used the DEA model to evaluate the economic security efficiency of China's logistics[7]. With the in-depth study of logistics efficiency, researchers have also adopted the combination of DEA model and other methods. For example, Zhou Gengui (2008) used stepwise regression method combined with DEA model to analyze the efficiency of China's third-party logistics and related influencing factors[8]. Coto-Millan, P(2016) used DEA model and TOBIT model to analyze the influencing factors of airport logistics in Spain from 2009 to 2011, and obtained the specific situation of pure technical efficiency and scale efficiency of airport logistics[9].

Shang Kun (2019) focused on the existing problems of tobacco logistics and proposed measures to strengthen the lean logistics management of tobacco industry enterprises by referring to the concept of lean logistics management, hoping to provide some reference for relevant professionals[10]. Feng Xiaochen

(2017) will analyze the problems existing in logistics cost management of China's tobacco industry enterprises and explore effective strategies to solve the problems, in order to provide valuable reference for promoting the development of China's tobacco industry enterprises[11]. Zou Pinguang (2016) put forward a strategic plan for the construction of tobacco industrial logistics under market-oriented reform based on a comprehensive analysis of the operating status of industrial enterprises and the characteristics of tobacco logistics. First of all, change the way of thinking, integrate resources, optimize the process and unify the standard, so as to implement logistics data informatization, professional talent team and intelligent market analysis, and finally achieve the strategic goal of improving logistics service level and realizing "irreplaceable" tobacco logistics[12].

Liu Manzhi et al. (2009) selected the number of employees in transportation, warehousing, post and telecommunications, the ownership of civil vehicles and highway mileage as input indicators, and selected the city's GDP and highway cargo transportation volume as output indicators In the calculation of urban logistics efficiency to construct a DEA model to analyze the situation of logistics input redundancy and output shortage[13]. Li Juan and Wang Qinmei (2019) measured the quality and balance of logistics development in China's four major sectors based on the measure of logistics efficiency, and selected the quantitative indicators of input indicators in the evaluation index system as investment in fixed assets of logistics industry, energy consumption of logistics industry and the number of employees in logistics industry, while the quantitative indicators of output indicators as the total output value of logistics industry and carbon dioxide emissions of logistics industry, and finally concluded that the logistics development in China's eastern, western, southern and northern sectors is unbalanced and briefly put forward policy suggestions for improvement[14].

EMPIRICAL ANALYSIS

Building an Evaluation Index System

The most important thing is to establish a scientific, reasonable and effective evaluation index system before the actual measurement of logistics efficiency. Therefore, in the process of selecting evaluation indexes, not only the basic characteristics of logistics development should be satisfied, but also the characteristics of logistics infrastructure network construction should be highlighted. As shown in Table 1, in this paper, based on the research of logistics infrastructure network construction, the logistics efficiency is measured by selecting the input indicators from the investment in logistics infrastructure network construction, the length of lines and the number of nodes in the construction of logistics infrastructure network, and the output indicators from the added value of logistics industry, the relative scale of logistics infrastructure network construction and the turnover volume of freight transportation.

Table 1
Selection and Arrangement of Logistics Efficiency Evaluation Indicators

Authors	Titles	Input indicators	Indicators
Liu Manzhi, Zhou Meihua and Yang Juan (2009) **Error! Reference source not found.**	Evaluation Model and Empirical Analysis of City Logistics Efficiency Based on DEA	Number of employees in transportation, warehousing, post and telecommunications Ownership of civil vehicles Highway mileage	Urban GDP Road freight volume
Li Juan and Wang Qinmei (2019) **Error! Reference**	The Measurement and Balance of the Development Quality of China's Four Major Plate Logistics Industry-Based on the Perspective of Logistics Industry Efficiency	Investment in fixed assets of logistics industry Logistics energy consumption Number of logistics industry employees	Gross output value of logistics industry Carbon dioxide emissions from logistics industry

source not found.			
Wang Lei; Xue Guoliang; Zhang Hongli (2014) **Error! Reference source not found.**	Analysis of Modern Logistics Efficiency in Northern Xinjiang Based on DEA Analysis	Investment in logistics industry Investment in public environment and social security Highway mileage	Highway freight volume Highway freight turnover Output value of logistics industry
Guo zixue; Zhang Yahui; Huang Xin (2018) **Error! Reference source not found.**	Evaluation of Logistics Efficiency in Beijing-Tianjin-Hebei Region Based on DEA Model	Number of employees in logistics industry Logistics mileage Investment in fixed assets of logistics industry	Logistics output value Volume of goods transported Turnover of goods
Wang Yuhong; Liu Qi (2017) **Error! Reference source not found.**	Measurement of Logistics Efficiency in Yangtze River Economic Belt Based on Super-SBM Model	Capital investment in logistics industry Labor input Energy input	Logistics added value Carbon dioxide emissions
Yu Liying; Shi Mingkang; Li Jing (2018) **Error! Reference source not found.**	Logistics Efficiency and Factor Decomposition of Yangtze River Economic Belt Based on DEA-Malmquist Index Model	Employees in logistics industry Investment in fixed assets of logistics industry Carbon emissions from logistics industry	Turnover of goods Gross value of logistics industry

Data source: collated based on literature review

According to the operability principle of selecting evaluation indicators, all evaluation indicators are quantified in this paper, as shown in Table 2.

Table 2
Logistics Efficiency Evaluation Indicator System Based on Logistics Infrastructure Network Construction

Basic indicators	Evaluation indicators	Descriptions
Input indicators	Investment in logistics infrastructure network (100 million yuan) X_1	Investment in fixed assets in transportation, warehousing and postal services
	Logistics infrastructure network line length (10,000 km) X_2	Mileage of highway, railway and inland waterway
	Number of logistics infrastructure network nodes (points) X_3	Number of postal outlets
Output indicators	Added value of logistics industry (100 million yuan) Y_1	Added value of transportation, warehousing and postal services
	Relative scale of logistics infrastructure network (km/km^2) Y_2	Density of highway network
	Turnover of goods (ton, 10,000 km) Y_3	Original statistical indicators

Data Sources and Descriptive Statistics

Data Sources

In this paper, the panel data of 12 years from 2006 to 2017 are accurately selected, in which the data excluding the density of road network is calculated according to the formula: regional road transport mileage (10,000 km)/regional area (10,000 km^2) (the data of road transport mileage comes from China Statistical Yearbook 2019).

Descriptive Statistics of Data

Firstly, to understand the specific status of logistics input and output based on logistics infrastructure network construction, the cross-sectional data of eight major economic regions in 2017 are collated and summarized to get the following Tables 3 and 4.

Table 3
Descriptive Statistics of Logistics Efficiency Input Indicators in 2017

Regions	Maximum			Minimum			Mean			SD		
	X_1	X_2	X_3	X_1	X_2	X_3	X_1	X_2	X_3	X_1	X_2	X_3
Northern coastal comprehensive economic zone	3955	27.74	14936	537.02	1.77	2084	1939.15	12.94	7285.00	1296.56	11.23	4754.20
	X_1	X_2	X_3	X_1	X_2	X_3	X_1	X_2	X_3	X_1	X_2	X_3
Northeast comprehensive economic region	1211.74	17.73	7125	602.01	11.04	4711	1004.76	13.89	5884.67	284.83	2.82	986.64
Eastern coastal comprehensive economic zone	2967.46	18.57	26487	960.28	1.59	15190	2272.91	11.14	19350.33	928.69	7.09	5069.48
Southern coastal economic zone	3759.6	23.59	24234	486.03	3.2	1714	2351.50	12.74	11752.00	1375.01	8.38	9354.77
Comprehensive economic zone in the middle reaches of Yellow River.	2498.51	27.46	12150	425.47	14.91	4605	1498.83	20.47	8864.75	775.71	4.65	2783.13
Comprehensive economic zone in the middle reaches of Yangtze River	2939.88	28.21	14222	734.6	17.22	9810	1861.66	23.09	11230.50	795.19	4.18	1752.61
Southwest comprehensive economic zone	4492.62	34.56	18962	1954.8	13.42	6583	2905.81	21.72	9838.60	1025.48	7.57	4591.52
Northwest comprehensive economic zone	1978.5	19.12	4863	330.08	3.61	970	915.48	10.98	2398.40	569.21	5.40	1606.83
Nationwide	4492.62	34.56	26487	330.08	1.59	970	1844.92	16.22	9086.03	1145.11	8.67	6449.31

Note.
X_1 represents fixed assets investment in transportation, warehousing and postal services, X_2 represents mileage of highways, railways and inland waterways, and X_3 represents postal service outlets.

Table 4
Descriptive Statistics of Logistics Efficiency Output Indicators in 2017

Regions	Maximum			Minimum			Mean			SD		
	Y_1	Y_2	Y_3	Y_1	Y_2	Y_3	Y_1	Y_2	Y_3	Y_1	Y_2	Y_3
Northern coastal comprehensive economic zone	3268.01	1.72	13381.59	780.4	1.01	958.42	1938.67	1.38	6557.25	994.33	0.26	5176.15
Northeast comprehensive economic region	1310.02	0.84	12757.2	603.12	0.35	1634.65	904.82	0.58	5349.85	297.72	0.20	5237.80
Eastern coastal comprehensive economic zone	3097.67	2.10	24998.71	1344.5	1.18	9057.60	2126.79	1.61	14720.85	728.03	0.38	7280.14
Southern coastal economic zone	3580.94	1.22	27919.79	248.94	0.89	864.26	1906.52	1.01	11854.60	1360.34	0.15	11613.67
Comprehensive economic zone in the middle reaches of Yellow River	2162.85	1.60	8228.7	832.62	0.17	3760.64	1274.41	0.88	5330.28	520.64	0.51	1747.13
Comprehensive economic zone in the middle reaches of Yangtze River	1496.01	1.46	11429.77	866.3	0.97	4217.34	1164.43	1.25	6573.15	294.83	0.21	2930.55
Southwest comprehensive economic zone	1595.8	1.78	4613.32	366.59	0.52	1656.48	985.55	0.94	2833.05	391.33	0.47	1084.59
Northwest comprehensive economic zone	668.15	0.52	2439.66	34.08	0.07	136.30	259.75	0.23	1205.10	222.20	0.17	925.60
Nationwide	3580.94	2.10	27919.79	34.08	0.07	136.30	1243.58	0.95	6122.88	891.74	0.54	6591.01

Note.
Y_1 represents the added value of transportation, warehousing and postal services, Y_2 represents the density of highway network, and Y_3 represents the freight turnover volume

EFFICIENCY ANALYSIS of DEA-BCC MODEL

In this paper, DEAP 2.1 software is used, and DEA-BCC input-oriented model is applied to measure the logistics efficiency of 31 provinces and cities in China's eight major economic regions from 2006 to 2017 based on the construction of logistics infrastructure network. Static analysis is carried out from the comprehensive efficiency, pure technical efficiency, scale efficiency and scale reward. Considering that the DEA-BCC model is only applicable to the efficiency measurement of decision-making units with the same attributes at the same stage, 31 provinces and cities are taken as decision-making units to calculate the logistics efficiency year by year, totaling 12 groups (12 years) of data. After running the software to get the result, the 31 provinces and cities are divided into eight economic regions, and the arithmetic mean of the provinces and cities belonging to the economic region is taken as the efficiency value of the economic region.

Evaluation of Comprehensive Efficiency

Table 5
Comprehensive Efficiency of Logistics from 2006 to 2017

Regions	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Mean
Beijing	0.747	0.868	0.666	0.857	0.879	1.000	0.833	0.877	0.795	0.990	1.000	1.000	0.876
Tianjin	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Hebei	0.851	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.988
Shandong	1.000	1.000	1.000	1.000	1.000	1.000	0.946	0.792	0.821	0.771	0.788	0.587	0.892
Northern coastal comprehensive economic zone	**0.900**	**0.967**	**0.917**	**0.964**	**0.970**	**1.000**	**0.945**	**0.917**	**0.904**	**0.940**	**0.947**	**0.897**	**0.939**
Liaoning	0.578	0.731	0.953	0.757	0.700	0.842	0.813	0.966	0.925	1.000	1.000	1.000	0.855
Jilin	0.615	0.586	0.584	0.566	0.507	0.534	0.539	0.634	0.523	0.443	0.430	0.342	0.525
Heilongjiang	0.609	0.602	0.493	0.418	0.460	0.593	0.657	0.768	0.627	0.526	0.529	0.433	0.560
Northeast comprehensive economic region	**0.601**	**0.640**	**0.677**	**0.580**	**0.556**	**0.656**	**0.670**	**0.789**	**0.692**	**0.656**	**0.653**	**0.592**	**0.647**
Shanghai	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Jiangsu	0.768	0.920	0.927	0.941	1.000	1.000	0.986	0.971	0.722	0.867	0.867	0.679	0.887
Zhejiang	0.431	0.680	0.636	0.674	0.722	0.690	0.590	0.683	0.591	0.562	0.577	0.434	0.606
Eastern coastal comprehensive economic zone	**0.733**	**0.867**	**0.854**	**0.872**	**0.907**	**0.897**	**0.859**	**0.885**	**0.771**	**0.810**	**0.815**	**0.704**	**0.831**
Fujian	0.706	0.764	0.645	0.667	0.612	0.584	0.590	0.619	0.645	0.644	0.644	0.578	0.642
Guangdong	0.764	0.944	0.786	0.744	0.696	0.759	0.748	0.656	0.633	0.694	0.741	0.737	0.742
Hainan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.949	0.914	0.860	0.758	0.957
Southern coastal economic zone	**0.823**	**0.903**	**0.810**	**0.804**	**0.769**	**0.781**	**0.779**	**0.758**	**0.742**	**0.751**	**0.748**	**0.691**	**0.780**
Shaanxi	0.413	0.489	0.480	0.505	0.503	0.462	0.488	0.553	0.510	0.431	0.401	0.307	0.462
Shanxi	1.000	1.000	1.000	0.522	0.572	0.539	0.556	0.605	0.615	0.746	0.642	1.000	0.733
Henan	0.549	0.605	0.714	0.677	0.719	0.752	0.716	0.883	0.825	0.754	0.752	0.682	0.719
Inner Mongolia	**0.641**	**0.746**	**0.775**	**0.673**	**0.653**	**0.615**	**0.618**	**0.726**	**0.680**	**0.670**	**0.623**	**0.638**	**0.671**
Comprehensive economic zone in the middle reaches of Yellow River	0.513	0.602	0.595	0.598	0.629	0.573	0.462	0.525	0.505	0.451	0.373	0.322	0.512

Hubei	0.873	0.804	0.709	0.502	0.590	0.556	0.680	0.642	0.660	0.635	0.576	0.466	0.641
Hunan	0.571	0.743	0.952	0.773	0.748	0.671	0.735	0.796	0.623	0.722	0.613	0.646	0.716
Jiangxi	0.654	0.636	1.000	0.876	0.867	0.788	0.748	0.956	0.815	0.603	0.601	0.633	0.765
Anhui	**0.653**	**0.696**	**0.814**	**0.687**	**0.709**	**0.647**	**0.656**	**0.730**	**0.651**	**0.603**	**0.541**	**0.517**	**0.659**
Comprehensive economic zone in the middle reaches of Yangtze River	0.243	0.308	0.311	0.265	0.194	0.181	0.219	0.204	0.183	0.188	0.162	0.164	0.219
Yunnan	0.651	0.791	0.802	0.710	0.727	0.636	0.634	0.615	0.539	0.513	0.491	0.355	0.622
Guizhou	0.562	0.531	0.406	0.258	0.255	0.224	0.213	0.255	0.258	0.294	0.312	0.239	0.317
Sichuan	0.745	0.630	0.647	0.611	0.646	0.454	0.548	0.578	0.562	0.601	0.517	0.438	0.581
Chongqing	0.496	0.435	0.411	0.417	0.459	0.480	0.453	0.506	0.457	0.445	0.412	0.388	0.447
Guangxi	**0.539**	**0.539**	**0.515**	**0.452**	**0.456**	**0.395**	**0.413**	**0.432**	**0.400**	**0.408**	**0.379**	**0.317**	**0.437**
Southwest comprehensive economic zone	0.578	0.841	0.970	0.893	0.749	0.644	0.579	0.433	0.267	0.267	0.222	0.292	0.561
Gansu	0.275	0.332	0.334	0.336	0.371	0.396	0.395	0.217	0.238	0.275	0.283	0.334	0.316
Qinghai	0.917	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.869	0.922	0.674	0.579	0.913
Ningxia	0.119	0.190	0.172	0.202	0.167	0.127	0.183	0.203	0.150	0.093	0.100	0.107	0.151
Tibet	0.414	0.478	0.382	0.365	0.368	0.398	0.472	0.490	0.458	0.422	0.508	0.478	0.436
Xinjiang	**0.661**	**0.730**	**0.733**	**0.688**	**0.684**	**0.673**	**0.669**	**0.698**	**0.641**	**0.641**	**0.618**	**0.576**	**0.668**
Northwest comprehensive economic zone	**0.653**	**0.723**	**0.725**	**0.681**	**0.676**	**0.664**	**0.661**	**0.687**	**0.630**	**0.630**	**0.606**	**0.566**	**0.658**

Data source: calculated by DEAP 2.1 software

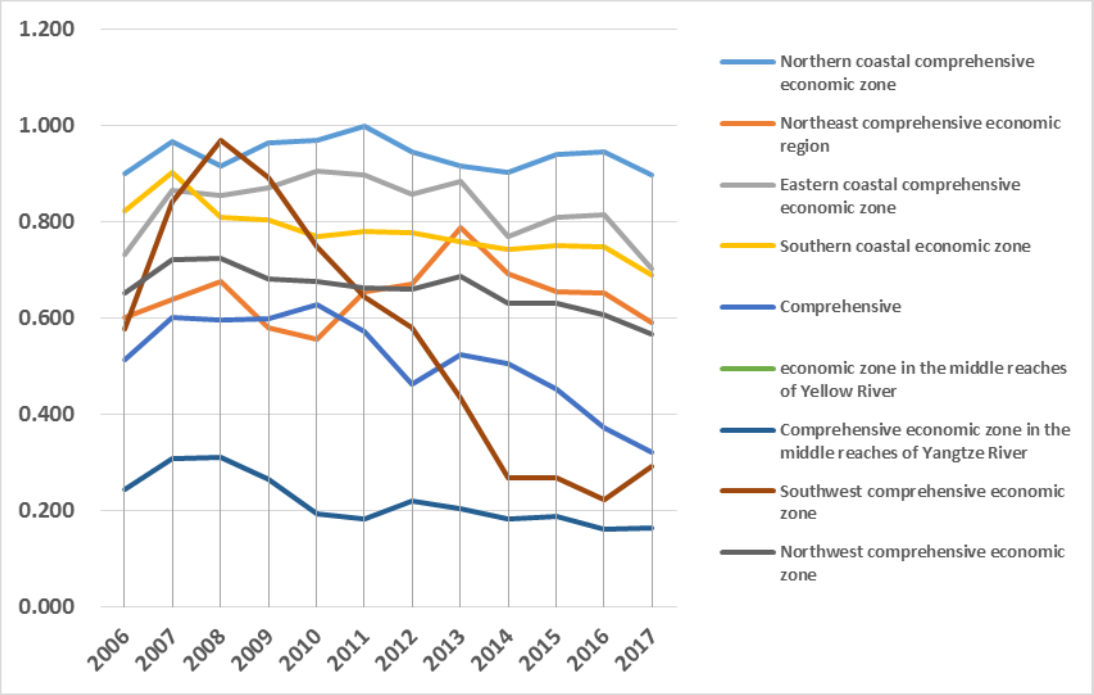

Fig. 1 Changes in Comprehensive Efficiency of Eight Economic Zones from 2006 to 2017
(Data source: calculated according to the data in Table 8)

Based on Table 5 and Fig. 1, the overall logistics efficiency in terms of logistics infrastructure network construction can be obtained. First of all, the comprehensive efficiency of national logistics showed a fluctuating state, which gradually increased from 2006 to 2008, but was in a downward trend from 2009 to 2012, and finally rose to 0.687 in 2013, but decreased to 0.566 in 2014-2017. According to the trend chart of logistics comprehensive efficiency of the eight major economic regions, overall, the comprehensive efficiency of the eight major economic regions showed an upward trend in 2006-2007 and fluctuated in 2007-2016. The comprehensive efficiency of the other seven economic regions except the comprehensive economic zone in the middle reaches of the Yellow River showed a downward trend in 2016-2017. Thus it is obvious that logistics based on logistics infrastructure network construction has obvious problems in the whole country in 2017, and the specific problems need to be further analyzed on pure technical efficiency and scale efficiency. As a whole, the logistics efficiency of the northern coastal integrated economic zone is in the leading position, followed by the eastern coastal integrated economic zone and the southern coastal integrated economic zone, while the logistics integrated efficiency of the rest of the regions were unstable in 2006-2017.

Pure Technical Efficiency

Table 6
Pure Technical Efficiency of Logistics from 2006 to 2017

Regions	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Mean
Beijing	0.846	1.000	0.952	0.930	0.910	1.000	0.836	0.877	0.813	1.000	1.000	1.000	0.930
Tianjin	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Hebei	0.916	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.993
Shandong	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Northern coastal comprehensive economic zone	**0.941**	**1.000**	**0.988**	**0.983**	**0.978**	**1.000**	**0.959**	**0.969**	**0.953**	**1.000**	**1.000**	**1.000**	**0.981**
Liaoning	0.635	0.733	1.000	0.766	0.702	0.843	0.819	0.972	0.933	1.000	1.000	1.000	0.867

Jilin	0.666	0.596	0.585	0.578	0.548	0.538	0.543	0.645	0.596	0.500	0.509	0.393	0.558
Heilongjiang	0.665	0.628	0.533	0.451	0.491	0.600	0.679	0.777	0.687	0.599	0.581	0.443	0.595
Northeast comprehensive economic region	**0.655**	**0.652**	**0.706**	**0.598**	**0.580**	**0.660**	**0.680**	**0.798**	**0.739**	**0.700**	**0.697**	**0.612**	**0.673**
Shanghai	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Jiangsu	0.856	0.944	0.953	0.968	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.977
Zhejiang	0.505	0.699	0.641	0.676	0.726	0.691	0.591	0.688	0.592	0.624	0.677	0.567	0.640
Eastern coastal comprehensive economic zone	**0.787**	**0.881**	**0.865**	**0.881**	**0.909**	**0.897**	**0.864**	**0.896**	**0.864**	**0.875**	**0.892**	**0.856**	**0.872**
Fujian	0.712	0.765	0.651	0.675	0.612	0.585	0.595	0.621	0.666	0.815	0.866	0.855	0.702
Guangdong	1.000	1.000	1.000	0.942	0.910	0.834	0.949	1.000	1.000	1.000	1.000	1.000	0.970
Hainan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.954	0.996
Southern coastal economic zone	**0.904**	**0.922**	**0.884**	**0.872**	**0.841**	**0.806**	**0.848**	**0.874**	**0.889**	**0.938**	**0.955**	**0.936**	**0.889**
Shaanxi	0.447	0.494	0.484	0.513	0.507	0.464	0.532	0.555	0.548	0.458	0.425	0.329	0.480
Shanxi	1.000	1.000	1.000	0.522	0.587	0.540	0.589	0.609	0.658	0.773	0.676	1.000	0.746
Henan	0.790	1.000	1.000	1.000	0.825	0.740	0.745	0.870	0.832	0.855	0.829	0.863	0.862
Inner Mongolia	0.570	0.641	0.742	0.696	0.728	0.766	0.741	0.887	0.862	0.802	0.754	0.733	0.744
Comprehensive economic zone in the middle reaches of Yellow River	**0.702**	**0.784**	**0.807**	**0.683**	**0.662**	**0.628**	**0.652**	**0.730**	**0.725**	**0.722**	**0.671**	**0.731**	**0.708**
Hubei	0.514	0.640	0.625	0.625	0.631	0.579	0.515	0.525	0.510	0.461	0.392	0.399	0.535
Hunan	1.000	1.000	0.865	0.562	0.928	1.000	1.000	0.642	0.733	0.732	0.695	0.884	0.837
Jiangxi	0.571	0.947	1.000	0.954	0.765	0.734	0.755	0.801	0.657	0.750	0.665	0.665	0.772
Anhui	0.684	0.855	1.000	0.883	0.873	0.797	0.748	0.963	0.838	0.627	0.627	0.676	0.798
Comprehensive economic zone in the middle reaches of Yangtze River	**0.692**	**0.861**	**0.873**	**0.756**	**0.799**	**0.778**	**0.755**	**0.733**	**0.685**	**0.643**	**0.595**	**0.656**	**0.735**
Yunnan	0.266	0.310	0.341	0.295	0.212	0.204	0.227	0.235	0.234	0.267	0.238	0.220	0.254
Guizhou	0.678	0.897	0.820	0.755	0.736	0.665	0.686	0.616	0.558	0.525	0.497	0.362	0.650
Sichuan	0.595	0.542	0.427	0.270	0.260	0.225	0.215	0.257	0.269	0.304	0.317	0.286	0.331
Chongqing	1.000	1.000	1.000	0.814	0.771	0.631	0.693	0.598	0.562	1.000	0.826	1.000	0.825
Guangxi	0.559	0.470	0.440	0.447	0.484	0.495	0.469	0.512	0.504	0.486	0.437	0.415	0.477
Southwest comprehensive economic zone	**0.620**	**0.644**	**0.606**	**0.516**	**0.493**	**0.444**	**0.458**	**0.444**	**0.425**	**0.516**	**0.463**	**0.457**	**0.507**
Gansu	0.730	0.994	1.000	0.995	0.851	0.662	0.583	0.508	0.390	0.378	0.378	0.433	0.659
Qinghai	0.998	0.947	0.987	1.000	1.000	1.000	1.000	0.657	0.808	1.000	1.000	1.000	0.950
Ningxia	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Tibet	1.000	1.000	1.000	1.000	1.000	0.956	1.000	1.000	1.000	1.000	1.000	1.000	0.996
Xinjiang	0.532	0.577	0.454	0.426	0.420	0.403	0.486	0.502	0.540	0.508	0.630	0.526	0.500
Northwest comprehensive economic zone	**0.852**	**0.904**	**0.888**	**0.884**	**0.854**	**0.804**	**0.814**	**0.733**	**0.748**	**0.777**	**0.802**	**0.792**	**0.821**
Nationwide	**0.766**	**0.828**	**0.823**	**0.766**	**0.757**	**0.740**	**0.742**	**0.752**	**0.735**	**0.757**	**0.743**	**0.742**	**0.763**

Data source: calculated by DEAP 2.1 software

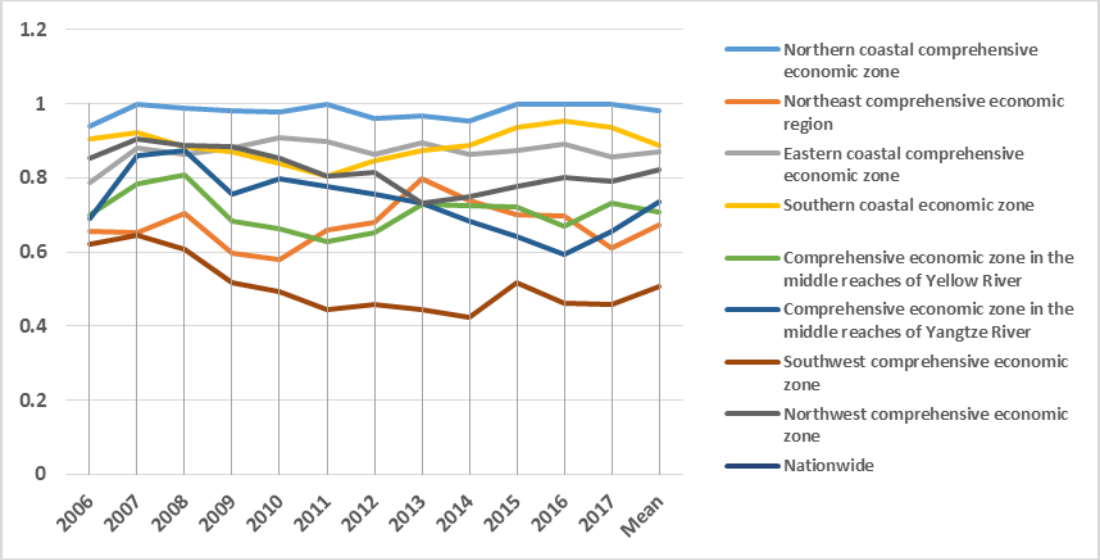

Fig. 2 Changes of Pure Technical Efficiency in Eight Economic Zones from 2006 to 2017
(Data source: calculated according to the data in Table 6)

According to the above two charts, the average value of the national logistics pure technical efficiency is 0.763. The pure technical efficiency in the northern coastal comprehensive economic zone is at the highest value, while the technical management level in the southwest comprehensive economic zone is at a backward stage, and the pure technical efficiency is fluctuating and decreasing as a whole, which indicates that the logistics management and technical level in southwest China need to be improved urgently. The pure technical efficiency of the eastern coastal comprehensive economic zone and the southern coastal comprehensive economic zone is almost the same. Before 2014, the pure technical efficiency of the eastern coastal comprehensive economic zone was higher than that of the southern coastal comprehensive economic zone. However, since 2014, the southern coastal zone started to catch up and its pure technical efficiency has been higher than that of the eastern coastal comprehensive economic zone, which indicates that the technical and management levels of the two regions are in a high position. The rest of the economic regions are at a better-than-average level, but the value of pure technical efficiency is almost always between 0.6 and 0.85, indicating that the logistics technology and management level of other regions in China are generally balanced although they need to be strengthened.

Scale Efficiency

Table 7
Logistics Scale Efficiency from 2006 to 2017

Regions	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Mean
Beijing	0.883	0.868	0.700	0.921	0.966	1.000	0.997	1.000	0.978	0.990	1.000	1.000	0.942
Tianjin	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Hebei	0.928	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.994
Shandong	1.000	1.000	1.000	1.000	1.000	1.000	0.946	0.792	0.821	0.771	0.788	0.587	0.892
Northern coastal comprehensive economic zone	**0.953**	**0.967**	**0.925**	**0.980**	**0.992**	**1.000**	**0.986**	**0.948**	**0.950**	**0.940**	**0.947**	**0.897**	**0.957**
Liaoning	0.910	0.997	0.953	0.988	0.997	0.999	0.992	0.994	0.991	1.000	1.000	1.000	0.985
Jilin	0.923	0.983	0.998	0.980	0.925	0.993	0.992	0.983	0.878	0.885	0.845	0.872	0.938
Heilongjiang	0.917	0.958	0.924	0.926	0.938	0.990	0.967	0.988	0.912	0.879	0.910	0.979	0.941

Northeast comprehensive economic region	**0.917**	**0.979**	**0.958**	**0.965**	**0.953**	**0.994**	**0.984**	**0.988**	**0.927**	**0.921**	**0.918**	**0.950**	**0.955**
Shanghai	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Jiangsu	0.897	0.974	0.973	0.972	1.000	1.000	0.986	0.971	0.722	0.867	0.867	0.679	0.909
Zhejiang	0.853	0.973	0.993	0.997	0.995	0.999	0.999	0.994	0.998	0.900	0.853	0.766	0.943
Eastern coastal comprehensive economic zone	**0.917**	**0.982**	**0.989**	**0.990**	**0.998**	**1.000**	**0.995**	**0.988**	**0.907**	**0.922**	**0.907**	**0.815**	**0.951**
Fujian	0.992	0.998	0.990	0.988	1.000	0.997	0.992	0.997	0.969	0.790	0.744	0.676	0.928
Guangdong	0.764	0.944	0.786	0.790	0.765	0.911	0.788	0.656	0.633	0.694	0.741	0.737	0.767
Hainan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.949	0.914	0.860	0.794	0.960
Southern coastal economic zone	**0.919**	**0.981**	**0.925**	**0.926**	**0.922**	**0.969**	**0.927**	**0.884**	**0.850**	**0.799**	**0.782**	**0.736**	**0.885**
Shaanxi	0.926	0.989	0.992	0.984	0.992	0.997	0.918	0.996	0.931	0.940	0.945	0.933	0.962
Shanxi	1.000	1.000	1.000	1.000	0.974	0.997	0.945	0.992	0.936	0.965	0.950	1.000	0.980
Henan	0.760	0.889	0.905	0.987	0.993	0.957	0.956	0.993	0.926	0.875	0.842	0.650	0.894
Inner Mongolia	0.963	0.944	0.963	0.972	0.987	0.982	0.967	0.996	0.958	0.940	0.997	0.931	0.967
Comprehensive economic zone in the middle reaches of Yellow River	**0.912**	**0.956**	**0.965**	**0.986**	**0.987**	**0.983**	**0.947**	**0.994**	**0.938**	**0.930**	**0.934**	**0.879**	**0.951**
Hubei	0.999	0.941	0.951	0.958	0.998	0.990	0.897	0.999	0.989	0.979	0.951	0.806	0.955
Hunan	0.873	0.804	0.819	0.893	0.636	0.556	0.680	1.000	0.901	0.868	0.829	0.528	0.782
Jiangxi	1.000	0.785	0.952	0.811	0.977	0.914	0.973	0.994	0.948	0.963	0.921	0.970	0.934
Anhui	0.956	0.744	1.000	0.991	0.994	0.988	1.000	0.992	0.972	0.962	0.958	0.937	0.958
Comprehensive economic zone in the middle reaches of Yangtze River	**0.957**	**0.819**	**0.931**	**0.913**	**0.901**	**0.862**	**0.888**	**0.996**	**0.953**	**0.943**	**0.915**	**0.810**	**0.907**
Yunnan	0.913	0.991	0.911	0.897	0.914	0.888	0.964	0.872	0.783	0.706	0.680	0.747	0.856
Guizhou	0.960	0.882	0.978	0.940	0.988	0.956	0.925	0.998	0.966	0.977	0.987	0.980	0.961
Chongqing	0.745	0.630	0.647	0.751	0.838	0.720	0.792	0.967	0.999	0.601	0.625	0.438	0.729
Guangxi	0.888	0.926	0.934	0.932	0.948	0.971	0.966	0.988	0.908	0.914	0.943	0.935	0.938
Southwest comprehensive economic zone	**0.890**	**0.882**	**0.884**	**0.895**	**0.933**	**0.906**	**0.928**	**0.963**	**0.923**	**0.833**	**0.844**	**0.787**	**0.889**
Gansu	0.792	0.846	0.970	0.897	0.880	0.974	0.993	0.851	0.683	0.707	0.587	0.673	0.821
Qinghai	0.275	0.351	0.338	0.336	0.371	0.396	0.395	0.331	0.295	0.275	0.283	0.334	0.332
Ningxia	0.917	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.869	0.922	0.674	0.579	0.913
Tibet	0.119	0.190	0.172	0.202	0.167	0.133	0.183	0.203	0.150	0.093	0.100	0.107	0.152
Xinjiang	0.777	0.828	0.842	0.857	0.875	0.986	0.972	0.976	0.848	0.831	0.807	0.908	0.876
Northwest comprehensive economic zone	**0.576**	**0.643**	**0.664**	**0.658**	**0.659**	**0.698**	**0.709**	**0.672**	**0.569**	**0.566**	**0.490**	**0.520**	**0.619**
Nationwide	**0.867**	**0.884**	**0.892**	**0.901**	**0.906**	**0.913**	**0.909**	**0.920**	**0.867**	**0.844**	**0.828**	**0.787**	**0.876**

Data source: calculated by DEAP2.1 software.

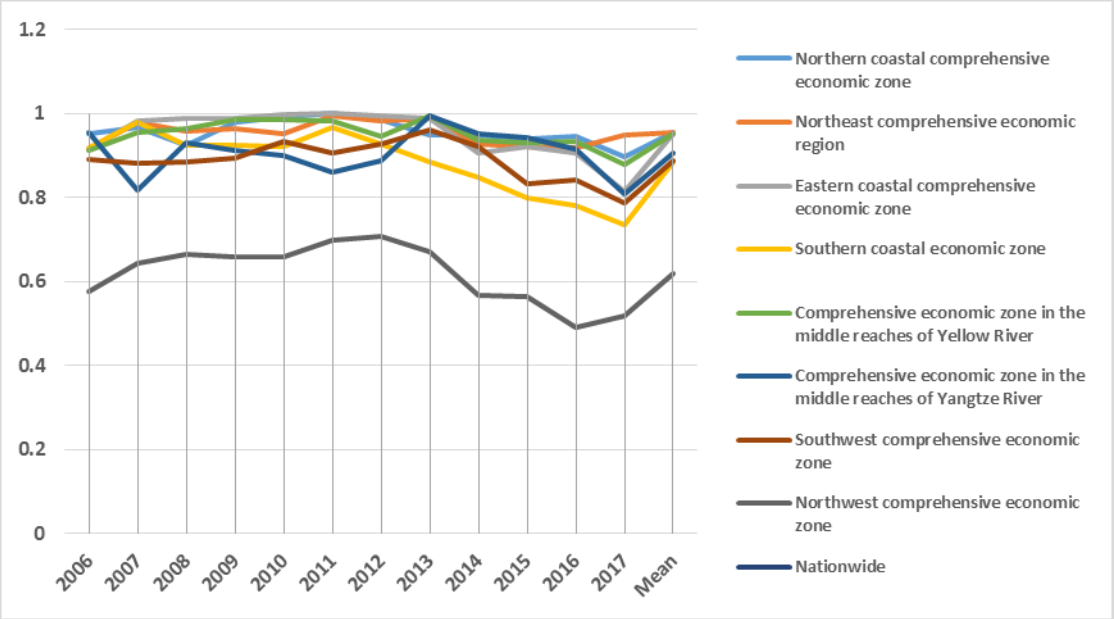

Fig. 3 Changes in Scale Efficiency of Eight Economic Zones from 2006 to 2017
(Data source: calculated according to the data in Table 7)

According to the logistics scale efficiency of the eight major economic regions, the average scale efficiency of the whole country is 0.876. Overall, the scale efficiency increased year by year from 2006 to 2011 and decreased year by year from 2013 to 2017. According to the line chart of logistics scale efficiency of China's eight major economic zones from 2006 to 2017, except for the Northwest Comprehensive Economic Zone, which is the region with the smallest scale efficiency among the eight major economic zones in the country, the efficiency values of the rest regions are almost all concentrated at 0.8-1, and it is not clear which specific economic zone is in the leading position from the line chart, indicating that the logistics scale investment based on the construction of logistics infrastructure network in China has developed steadily and is in good condition. Further research and analysis on scale remuneration are needed for the further improvement of the logistics industry.

Returns to Scale

As shown in Table 8, the scale of logistics infrastructure network in China's eight major economic zones can be adjusted accordingly through the specific scale rewards of logistics efficiency from 2006 to 2017. As a whole, the scale of China's logistics infrastructure network is not within a reasonable range and should be adjusted accordingly.

Table 8
Return of Logistics Scale from 2006 to 2017

Regions		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Northern coastal comprehensive economic zone	Beijing	drs	drs	drs	drs	drs	-	irs	-	drs	irs	-	-
	Tianjin	-	-	-	-	-	-	-	-	-	-	-	-
	Hebei	drs	-	-	-	-	-	-	-	-	-	-	-
	Shandong	-	-	-	-	-	-	drs	drs	drs	drs	drs	drs
Northeast comprehensive economic region	Liaoning	drs	irs	drs	irs	irs	irs	irs	irs	irs	-	-	-
	Jilin	irs	irs	irs	irs	irs	irs	drs	irs	irs	irs	irs	irs

	Heilongjiang	irs	irs	irs	irs	irs	irs	drs	irs	irs	irs	irs	irs
Eastern coastal comprehensive economic zone	Shanghai	-	-	-	-	-	-	-	-	-	-	-	-
	Jiangsu	drs	drs	drs	drs	-	-	drs	drs	drs	drs	drs	drs
	Zhejiang	drs	drs	drs	irs	irs	irs	drs	drs	drs	drs	drs	drs
Southern coastal economic zone	Fujian	irs	irs	irs	irs	-	irs	irs	irs	drs	drs	drs	drs
	Guangdong	drs	drs	drs	drs	drs	drs	drs	drs	drs	drs	drs	drs
	Hainan	-	-	-	-	-	-	-	-	irs	irs	irs	irs
Comprehensive economic zone in the middle reaches of Yellow River	Inner Mongolia	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs
	Shaanxi	irs	irs	drs	drs	irs	irs	drs	irs	irs	irs	irs	irs
	Shanxi	-	-	-	-	irs	irs	drs	irs	irs	irs	irs	-
	Henan	drs	drs	drs	drs	drs	drs	drs	drs	drs	drs	drs	drs
Comprehensive economic zone in the middle reaches of Yangtze River	Hubei	drs	drs	drs	drs	irs	drs	drs	-	irs	drs	drs	drs
	Hunan	drs	drs	drs	drs	drs	drs	drs	-	drs	drs	drs	drs
	Jiangxi	-	drs	drs	drs	drs	drs	drs	irs	irs	irs	irs	irs
	Anhui	drs	drs	-	drs	drs	drs	-	irs	irs	irs	irs	drs
Southwest comprehensive economic zone	Yunnan	irs	drs	drs	drs	irs	irs	drs	irs	irs	irs	irs	irs
	Guizhou	irs	drs	drs	drs	drs	drs	drs	irs	irs	irs	irs	drs
	Sichuan	irs	irs	irs	irs	irs	irs	drs	irs	irs	irs	drs	drs
	Chongqing	drs	drs	drs	drs	drs	drs	drs	drs	-	drs	drs	drs
	Guangxi	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs
Northwest comprehensive economic zone	Gansu	irs	irs	irs	irs	irs	irs	drs	irs	irs	irs	irs	irs
	Qinghai	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs
	Ningxia	irs	-	-	-	-	-	-	-	irs	irs	irs	irs
	Tibet	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs	irs
	Xinjiang	irs	irs	irs	irs	irs	irs	drs	irs	irs	irs	irs	irs

Data source: Calculated by running DEAP2.1 software

The overall scale of the northern comprehensive economic zone is reasonable, except for "drs" in Shandong Province, which indicates that the continuous expansion of scale will not achieve greater logistics efficiency, so it is necessary to reduce the scale of logistics infrastructure network. Except for Liaoning, which has shown the best scale efficiency since 2015, all other provinces and cities in the Northeast Comprehensive Economic Zone have "irs" for their returns on logistics scale, indicating that higher logistics efficiency can be obtained by continuing to expand the scale of logistics infrastructure network, so it is necessary to continue to expand the scale to improve logistics efficiency. Therefore, Jilin and Heilongjiang in the region need to expand the scale of logistics infrastructure network. Shanghai in the eastern coastal comprehensive economic zone does not need to make any adjustment due to its stable return on scale. Jiangsu and Zhejiang Provinces are both "drs" and need to reduce scale investment.

In the southern coastal comprehensive economic zone, the logistics scale of Fujian Province was too small before 2013 but too large between 2013 and 2017, which indicates that although Fujian Province realized the problems in logistics scale construction in 2013, but did not grasp the appropriate logistics infrastructure network scale. Therefore, it is necessary to reduce the logistics scale at the current stage. The scale of Guangdong Province is too large, while Hainan's logistics scale does not need to be adjusted before 2013, but it should expand the logistics infrastructure network scale after 2013, indicating that with the economic development and the expansion of logistics demand in Hainan Province, there is no corresponding adjustment to the logistics scale.

The comprehensive economic zones in the middle reaches of the Yellow River, the middle reaches of the

Yangtze River and the southwest regions have different scales of logistics development. Some provinces and cities need to continue to expand their scale, while others need to reduce their scale investment. However, almost all provinces and cities in the Northwest Comprehensive Economic Zone are in the stage of increasing returns to scale, indicating that the Northwest Comprehensive Economic Zone may have too small a logistics scale due to economic backwardness and other problems. Therefore, it is necessary to expand the construction of logistics infrastructure network in order to improve the overall efficiency of logistics and promote the balanced and high-quality development of the Northwest Comprehensive Economic Zone.

Malmquist Exponential Model Analysis

In the research of DEA-BCC model, only the cross-sectional data of each year is selected to measure the comprehensive efficiency of logistics, and the comprehensive efficiency is decomposed into pure technical efficiency and scale efficiency, which can only be measured in a static period, without considering the technology progress of enterprises or industries over time in real life. With Malmquist total factor index model, the technological progress is fully considered, and the panel data of eight economic zones from 2006 to 2017 are selected to dynamically decompose the logistics efficiency.

Change and Decomposition of Malmquist Total Factor Productivity in Eight Economic Zones

The total factor index of the eight economic zones from 2006 to 2017 is changed over time and decomposed, and the specific analysis of the eight economic zones is carried out according to the Table 9 below.

Except for the northwest comprehensive economic zone, where the total factor productivity index increased by 0.4% (due to the improvement of technical progress and pure technical efficiency), the other seven economic zones all had a total factor index of less than 1, mainly because of the backward logistics technology progress, which indicated that each region should pay attention to the impact of technological progress as time went by.

Table 9
Descriptive Statistics of Changes and Decomposition Samples of Logistics Malmquist Index in 31 Provinces and Cities in China from 2006 to 2017

Regions	Comprehensive efficiency	Technical progress	Pure technical efficiency	Scale efficiency	Total factor productivity
Beijing	1.028	0.725	1.008	1.019	0.746
Tianjin	1.035	0.770	1.032	1.003	0.797
Hebei	1.036	0.773	1.036	1.000	0.801
Shandong	1.036	0.860	1.036	1.000	0.891
Northern coastal comprehensive economic zone	**1.034**	**0.782**	**1.028**	**1.006**	**0.809**
Liaoning	1.027	0.879	1.026	1.001	0.903
Jilin	1.000	0.891	1.000	1.000	0.891
Heilongjiang	1.019	0.878	1.018	1.001	0.895
Northeast comprehensive economic region	**1.015**	**0.883**	**1.015**	**1.001**	**0.896**
Shanghai	0.891	0.889	1.008	0.884	0.792

Jiangsu	0.888	0.915	1.006	0.883	0.813
Zhejiang	0.884	0.952	1.003	0.881	0.841
Eastern coastal comprehensive economic zone	**0.888**	**0.919**	**1.006**	**0.883**	**0.815**
Fujian	0.886	0.882	1.000	0.886	0.782
Guangdong	0.865	0.881	0.970	0.892	0.762
Hainan	0.883	0.850	0.986	0.896	0.750
Southern coastal economic zone	**0.878**	**0.871**	**0.985**	**0.891**	**0.765**
Shaanxi	0.886	0.872	0.984	0.900	0.773
Shanxi	0.880	0.874	0.969	0.908	0.769
Henan	0.859	0.873	0.949	0.906	0.750
Inner Mongolia	0.803	0.844	0.922	0.870	0.677
Comprehensive economic zone in the middle reaches of Yellow River	**0.857**	**0.866**	**0.956**	**0.896**	**0.742**
Hubei	0.802	0.822	0.917	0.875	0.659
Hunan	0.795	0.815	0.909	0.874	0.647
Jiangxi	0.943	0.811	0.950	0.992	0.765
Anhui	0.955	0.867	0.959	0.996	0.828
Comprehensive economic zone in the middle reaches of Yangtze River	**0.874**	**0.829**	**0.934**	**0.934**	**0.725**
Yunnan	0.947	0.865	0.996	0.951	0.819
Guizhou	0.927	0.901	0.971	0.954	0.835
Sichuan	0.925	1.001	0.985	0.940	0.926
Chongqing	0.944	1.124	1.016	0.929	1.061
Guangxi	0.950	1.067	1.017	0.934	1.014
Southwest comprehensive economic zone	**0.939**	**0.992**	**0.997**	**0.942**	**0.931**
Gansu	0.921	1.054	1.000	0.921	0.971
Qinghai	0.930	1.129	1.003	0.927	1.050
Ningxia	0.935	1.118	1.005	0.931	1.046
Tibet	0.926	1.139	1.000	0.926	1.055
Xinjiang	0.940	1.144	1.000	0.940	1.076
Northwest comprehensive economic zone	**0.930**	**1.117**	**1.002**	**0.929**	**1.040**
Nationwide	**0.925**	**0.911**	**0.989**	**0.935**	**0.843**

Data source: calculated by running DEAP2.1 software

Dynamic Evaluation of Malmquist Total Factor Index in China

As shown in Table 10 below, China's logistics industry based on the construction of logistics infrastructure network has a comprehensive efficiency value of 0.925 from 2006 to 2017, which is broken down into pure technical efficiency and scale efficiency, being 0.989 and 0.843 respectively,

technological progress is 0.911, and the average value of total factor productivity is 0.843, indicating that China's logistics total factor index showed a downward trend during the research period mainly due to low scale efficiency.

Table 10
Changes and Decomposition of Logistics Malmquist Index in 31 Provinces and Cities in China from 2006 to 2017

Years	Comprehensive efficiency	Technical progress	Pure technical efficiency	Scale efficiency	Total factor productivity
2006-2007	1.069	0.321	1.078	0.992	0.343
2007-2008	0.667	1.691	0.735	0.908	1.128
2008-2009	1.365	0.813	1.256	1.087	1.11
2009-2010	1.098	0.895	1.074	1.022	0.983
2010-2011	0.901	0.704	0.952	0.946	0.634
2011-2012	1.051	0.943	1.021	1.029	0.991
2012-2013	1.08	1.018	1.04	1.038	1.099
2013-2014	0.743	0.851	0.874	0.849	0.632
2014-2015	1.132	1.099	1.031	1.098	1.244
2015-2016	0.769	1.395	0.874	0.88	1.073
2016-2017	0.6	1.032	1.044	0.575	0.619
Mean	0.925	0.911	0.989	0.935	0.843

Data source: calculated by running DEAP2.1 software

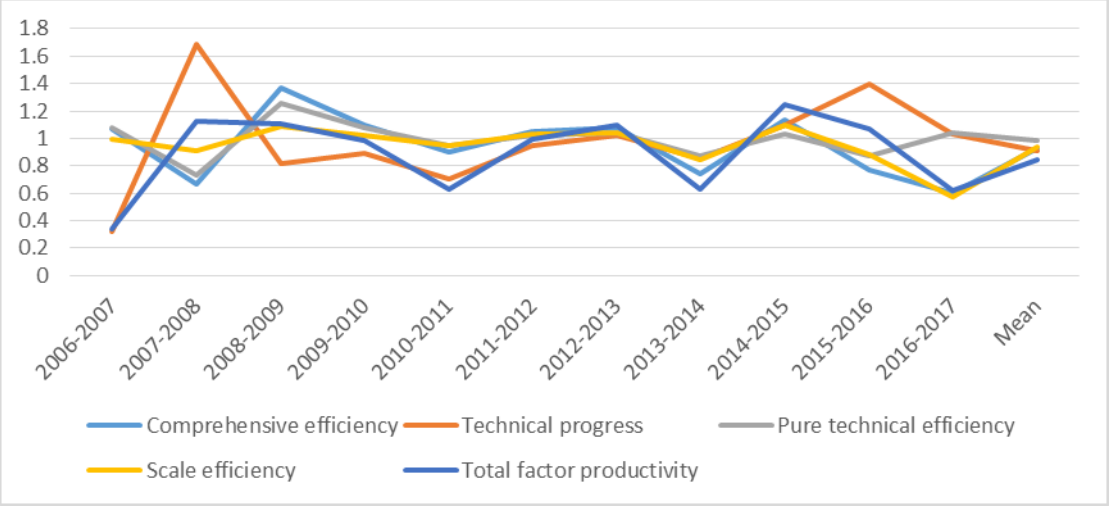

Fig. 4 Changes and Decomposition of Logistics Malmquist index in 31 Provinces and Cities in China from 2006 to 2017
(Data source: calculated according to the data in Table 10)

Based on the analysis in Fig. 4, the indicators of integrated efficiency and technological progress are more volatile except for the periods of 2006-2010 and 2014-2017. Moreover, the two indicators of comprehensive efficiency and technological progress are developing in opposite directions, with one showing an upward trend and the other beginning to decline, which restrict each other and jointly affect the total factor indicators. It indicates that the construction of China's logistics infrastructure network cannot be matched with the overall economic progress of the country at the same

time, probably because the market lag makes the input of logistics elements and the construction scale of logistics infrastructure network not match with the market demand, resulting in a large waste of logistics resources, unreasonable construction of logistics infrastructure network scale and low logistics efficiency.

COUNTERMEASURES and SUGGESTIONS to IMPROVE the EFFICIENCY of LOGISTICS INDUSTRY Based on the CONSTRUCTION of LOGISTICS INFRASTRUCTURE NETWORK

An empirical study based on logistic efficiency measurement in the eight largest economic regions of China reveals the reasons for the inefficiency of the logistic industry in terms of the logistics infrastructure network construction at this stage. In order to improve the efficiency of logistics in China in a targeted manner, specific countermeasures are proposed as follows:

Integrate and Optimize Logistics Resources and Create an Innovative Logistics Management Mechanism

1. Integrate resources to reduce costs on a large scale. The industry should integrate logistics resources, focus on optimization and reorganization, set up specialized logistics management organizations, raw materials should respond to the supply logistics system design, optimize the links of tobacco storage and internal distribution, and realize storage and distribution management in one. In order to strengthen the storage and distribution process of "short, fast", to achieve cost reduction, efficient operation, improve quality, fast delivery, further shorten the production and logistics response time.

2. Strengthen information support, use the information platform to unify tobacco storage, transportation and processing, build a high-quality and efficient modern logistics system, and realize process reengineering. Information system is the nerve center of modern tobacco logistics system and an important technical guarantee to improve logistics efficiency. It is an important strategic basis and premise to improve the core competitiveness of enterprises and promote the sustainable, rapid and healthy development of enterprises to realize the informatization construction of tobacco logistics in multiple directions and ways.

3. Make emergency plans for all links to improve the efficiency of dealing with emergencies; Strengthen lean management, effectively reduce costs and maximize resource utilization. With the hardware input of tobacco logistics, the management input needs to be improved synchronously. Embedding the new concept of lean management means resolutely abandoning the previous extensive logistics management concept, determining indicators on the basis of improving the evaluation mechanism, realizing regular evaluation and promoting the improvement of lean logistics management.

Promoting the Informatization Construction and Improving the Logistics Technology Level in the Southwest Economic Zone

1. Construct network information platform. As the empirical analysis shows that the pure technical efficiency of the southwest comprehensive economic zone is at the lowest level, in order to effectively improve the pure technical efficiency of the region, it is necessary to improve the technical level of logistics infrastructure network construction, improve the informatization level of logistics infrastructure network and construct a public information platform in the southwest comprehensive economic zone.

2. Upgrade the public information network of logistics and transportation. It is necessary to strengthen the construction and upgrading of public information network of logistics and transportation in southwest economic zone, so as to promote the systematic connection between the public transportation platform there and the leading enterprises in China's logistics industry, and provide a series of service functions, such as cargo transportation status inquiry, vehicle cargo matching inquiry, container positioning function, transportation price inquiry, logistics investment and financial advice, etc.

3. Strengthen the construction of multimodal transport information system. Information should be shared among various modes of transportation and relevant departments, such as customs, railway, highway transportation department and transportation supervision bureau, etc., so as to provide enterprises with one-stop logistics multimodal transport services, such as accreditation, qualification examination, customs clearance inspection, credit rating evaluation

and customs clearance inspection, in a timely and accurate manner.

4. Establish a professional transportation structure adjustment system. The evaluation index system of transportation structure adjustment should be established in combination with qualitative and quantitative analysis methods using big data technology, to promote the real-time monitoring of China's multimodal transport situation in a timely manner, submit relevant data and information, feedback the transportation structure, and conduct timely and targeted analysis and research.

Promoting the Networking Process of National Logistics Infrastructure and Improving the Comprehensive Efficiency of Logistics

Infrastructure of transport hub needs to be strengthened in order to realize multimodal transport smoothly, such as strengthening construction of large logistics park and national logistics hub, establishing multimodal transport system, connecting various modes of transport, establishing container handling station, port logistics hub, air transfer center, etc. In addition, the demonstration project of multimodal transport should be strongly supported, the operation monitoring of the demonstration project should be strengthened and the multimodal transport organization mode should be innovated. Moreover, relevant enterprise departments of demonstration projects are encouraged to develop relevant standard transport equipment, unify multimodal transport document templates, and run public information exchange platforms to take the lead in demonstration. Furthermore, the trial implementation of various multimodal transport modes should also be supported, such as roll on / roll off transportation of commercial vehicles, e-commerce express service trains, whole process cold chain transportation and container transportation.

CONCLUSIONS and PROSPECTS

Conclusions

In this paper, through research from the aspects of tobacco transportation logistics infrastructure network construction efficiency of logistics in our country, according to the present situation in the construction of logistics infrastructure network and China's eight major economic zones related to the specific data, the empirical conclusion logistics efficiency in the logistics infrastructure network construction in China there are some significant problems, and puts forward relevant improvement strategy and the following conclusions:

1. Logistics management concept of tobacco industry enterprises is backward. At present, tobacco industry enterprises have very limited understanding of logistics cost and logistics management system, and most enterprises lack effective logistics cost management system. The management of logistics cost only uses simple management to control the cost of each single logistics function, which is often left and right. At the same time, most of the raw materials, auxiliary materials, cigarette storage and transportation of industrial enterprises belong to different departments before the establishment of the logistics department, there are vague responsibilities and rights boundaries or even responsibilities and rights opposition phenomenon, which makes the logistics business communication is not smooth; Some enterprises each production point of logistics for the third party logistics, mutual lack of effective connection.

2. Logistics informatization of tobacco enterprises is weak. Most raw materials, auxiliary materials, supplies, storage, sorting, distribution and scheduling system of information resources are independent of each other, and data flow of information and the lack of effective integration integration, the other logistics informationization standard not unified, the industry standards related to enforcement, all kinds of code, code, and interface specification, standard, There are some difficulties in effective docking and information exchange and communication between various systems, and it is difficult to integrate and share logistics information, which further restricts the high-quality development of logistics of tobacco industry enterprises.

3. Diversification of factors restricting the development of efficiency of tobacco logistics. When analyzing the specific logistics related data of China's eight economic regions from 2006 to 2017 and the logistics efficiency value obtained by data Envelopment Model (DEA) and Malmquist index model, it is concluded that there are different factors restricting the efficient development of logistics in each region. The comprehensive efficiency of tobacco

logistics in the northern coastal comprehensive economic zone is in the forefront of the country, but its development has not kept up with the development of regional technological progress over time, and lags behind the regional economic development. The scale of logistics infrastructure network in the eastern coastal comprehensive economic zone is too small; The great southwest comprehensive economic zone has the problem of backward technology and other regions generally overinvest in logistics resources.

4. There are significant differences in the efficiency of tobacco logistics. There are significant differences in logistics efficiency between provinces and cities in some of the eight economic regions. The differences are not only reflected in the comprehensive efficiency value, but also in the specific influencing factors. For example, there is a great difference in the comprehensive efficiency of logistics within the northwest Comprehensive economic zone, the maximum value is about 9 times of the minimum value, and the main influencing factor in Gansu and Xinjiang is backward tobacco logistics management and science and technology, while the logistics infrastructure network construction scale in Qinghai and Xizang is inappropriate.

Prospects

In this paper, although the research on Tobacco transport logistics infrastructure network construction provides a certain reference for the future research in this field, and puts forward some countermeasures and suggestions for improving the construction of logistics infrastructure network by using DEA model and Malmquist index model, the research in this paper still has some deficiencies due to its limited knowledge level and difficulties in data collection. According to the current situation of logistics infrastructure network construction and the specific relevant specific data of China's eight major economic zones, there is no accurate record in the national professional statistical resources for some of the quantitative indicators of logistics efficiency required in this paper, so the specific data of other quantitative indicators are selected to replace them, and the scope of data collection can be further expanded according to the evaluation indicators selected for the influencing factors of logistics infrastructure network construction and the impact on its logistics efficiency.

Conflicts of Interest Disclosure Statement

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