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An Evaluation Method of Regional Logistics Competitiveness Based on TOPSIS-DEA Model

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Abstract: ***Logistics industry has gradually become an important industry to improve the competitiveness of regional economy. It is very necessary to evaluate the competitiveness of regional logistics industry and put forward targeted suggestions. In order to evaluate the logistics competitiveness of different regions in a certain period of time, this paper proposes a dynamic comprehensive evaluation model based on Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) and Data Envelopment Analysis(DEA). First of all, in order to overcome the shortcomings of traditional model based on cross-section data for static evaluation, the "development factor" is used to reward and punish the panel data, and the quadratic weighting method is used to comprehensively calculate the evaluation results of TOPSIS every year. Secondly, DEA-Malmquistis used to calculate the logistics efficiency. Next, TOPSIS and DEA evaluation results are drawn in the two-dimensional coordinate department. Finally, based on the data of Chinese provinces along the Belt and Road, the logistics competitiveness of regional logistics is studied. The results show that, through TOPSIS-DEA model, it can be clearly analyzed that Coastal China has strong logistics capacity and high logistics efficiency; the Southwest China, Inland China and Northeast China have weak logistics capacity but high logistics efficiency; the Northwest China has weak logistics capacity and low logistics efficiency.***

Keywords: improved TOPSIS; DEA-malmquist; dynamic comprehensive evaluation; logistics competitiveness

1. Introduction

In recent years, the logistics industry has been gradually valued. China has become a leading logistics country in the world. However, the developments of logistics industry in Chinese provinces are unbalanced and inadequate, So China is not a sustainable logistics country. It is very necessary to establish a set of methods to evaluate the competitiveness of regional logistics industry, find out the advantages and disadvantages of regional logistics industry, and put forward targeted countermeasures and suggestions.

Scholars generally evaluate Chinese regional logistics competitiveness from two aspects in recent years: logistics capacity and logistics efficiency. From the perspective of logistics capability, the evaluation result is calculated by Factor Analysis (FA), Fuzzy Comprehension Evaluation (FCE), TOPSIS and so on. When analyzing the logistics competitiveness of 9 provinces along the Silk Road, Pan Li and Huiping Peng adopted Entropy Weight(EW) and Grey Relation Analysis(GRA) to avoid subjectivity and fuzziness of evaluation [1]; Yan Zhang and Gang Zhao established the evaluation indicators of port logistics competitiveness by using Delphi method and FCE, then they evaluated the main port cities along the Yangtze River in Jiangsu Province [2]; Yang YC et al. used the mixed Multi-criteria Decision-making Method to establish the Analytic Hierarchy Process and GRA to evaluate the competitiveness of logistics ports in Pusan, Tokyo and Kaohsiung [3]. From the perspective of logistics efficiency, DEA and Stochastic Frontier Model (SFM) are often used to calculate logistics efficiency. Weiguo Wang and Yueyue Ma use Three-stage DEA-malmquis to evaluate the logistics industry efficiency of 30 provinces in China from 1997 to 2009 [4]; With the help of SFM, Yuan Fan and Limei Ma analyzed the evaluation of logistics efficiency in different regions, and concluded that there is a large gap in logistics among regions in China [5]; Shu quan Hong and Quan Ju Zhang used DEA and Artificial Neural Network to analyze the difference of logistics efficiency of cities in the Pearl River Delta before and after the China-US trade war [6]. To sum up, when scholars evaluate logistics competitiveness from the perspective of logistics capability, most scholars use cross-sectional data for static evaluation, which is not convincing; from the perspective of logistics efficiency, many scholars use DEA-malmquis to conduct dynamic evaluation on panel data, which is relatively more convincing.

Based on the above research, a dynamic comprehensive evaluation model of TOPSIS-DEA is proposed. From the perspective of logistics capability, the original data is given rewards and punishments according to the "development factors" to make the isolated panel data connected. Then, TOPSIS, indicators weight and time weight are used for quadratic weighting method. From the perspective of logistics efficiency, DEA-malmquis is used to rank the evaluation. Finally, the TOPSIS evaluation result and DEA evaluation result are drawn in the two-dimensional coordinate department. The model not only overcomes the defect of traditional TOPSIS which can only evaluate static data, but also combines logistics capability and logistics efficiency to comprehensively evaluate regional logistics competitiveness.

2. Materials and Methods

To evaluate Chinese logistics comprehensive, the model uses the improved TOPSIS to calculate the dynamic logistics capacity and use DEA-Malmquist to calculate the dynamic logistics efficiency. The evaluation results of TOPSIS-DEA model are drawn in the capacity-development efficiency two-dimensional coordinate department, which reflects the dynamic comprehensive logistics.

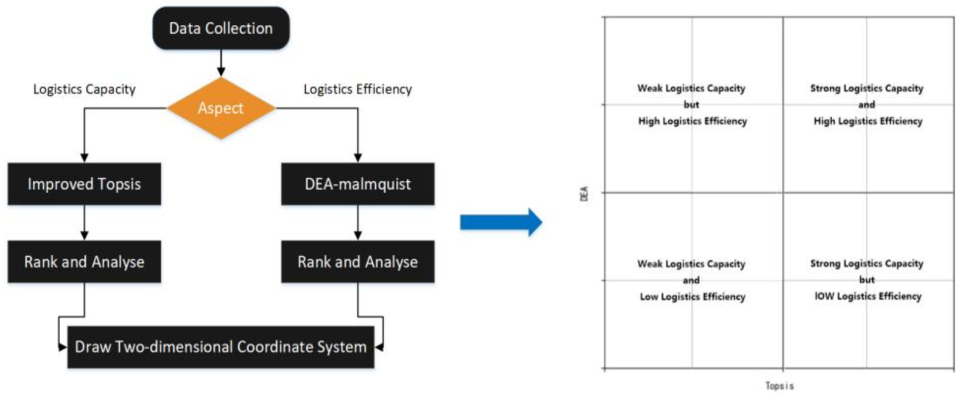

Figure 1: Flow-chart of TOPSIS-DEA model

2.1Logistics Capability Model

2.1.1. Data Preprocessing

Generally speaking, the indicators of the original data are of different orders of magnitude, and there is no comparability between them. Therefore, it is necessary to conduct the same trend and standardization processing on the initial data. The Same trend and standardized data are marked as$z_{ij}(t_k)$.

2.1.2. Development Factor

There is no relationship in the initial data, and the development trend of indicators is not considered. In this paper, in order to make the indicators including development trend better reflect the dynamic of the evaluation results, we define a "development factor" recorded as $\lambda(a_{ij}(t_k))$.Symbol ε is the undetermined parameter and $a_{ij}(t_k)$ is the linear growth rate of the change rate of the evaluated object.

$$\lambda\left(a_{ij}(t_k)\right) = \frac{\varepsilon}{1 + e^{-a_{ij}(t_k)}} \quad (1)$$

$$a_{ij}(t_k) = \begin{cases} 0 \quad , & k = 1 \\ \dfrac{v_{ij}(t_k) - v_{i,j}(t_k - t_{k-1})}{t_j(k) - t_j(k-1)}, & k = 2, \dots, N \end{cases} \quad (2)$$

$$v_{ij}(t_k) = \begin{cases} 0 \quad , & k = 1 \\ \dfrac{z_{i,j}(t_k) - z_{i,j}(t_{k-1})}{t_j(k) - t_j(k-1)}, & k = 2, \dots, N \end{cases} \quad (3)$$

When k = 0, there is no incentive measure of reward and punishment, so when a_{ij}= 0, $\lambda(a_{ij}(t_k))$ =1, then ε = 2.

- a_{ij} = 0, λ = 1, it means that it is in a stable state, and there is no reward or punishment incentive.
- a_{ij}> 0, λ> 1, it means rising state, and corresponding reward will be given.
- Ta_{ij}< 0, λ< 1, it means the state of descending, and punishment will be given.

$r_{ij}(t_k)$ is the result effected by "development factor", and the development degree of the data is adjusted by the "development factor".

$$r_{ij}(t_k) = \lambda\left(a_{ij}(t_k)\right) z_{ij}(t_k) (4)$$

2.1.3. Indicator Weight and Time Weight

Quadratic weighting method is an important method for dynamic evaluation. The indicator weight $w_j(t_k)$ should be given to different evaluation indicators, and the time weight $\tau(k)$ should be given to each time period.

EW uses the information entropy of data to calculate the weight of each evaluation indicators at different times. Among them, $e_j(t_k)$ is the information entropy of each indicator. σ is related to the sample size, usually, usually, σ = $1/lnn$.

$$e_j(t_k) = -\sigma \sum_{i=1}^{n} r_{ij}(t_k) \ln r_{ij}(t_k), (j = 1,2, \dots, m) \#(5)$$

$$w_j(t_k) = \frac{1 - e_j(t_k)}{\sum_{\sigma=1}^{m}\left(1 - e_\sigma(t_k)\right)}, \quad (j = 1,2, \dots, m) \quad \#(6)$$

$$\tau_k = \frac{k}{\sum_{k=1}^{N} k}, \quad (k = 1,2, \dots, N) \quad \#\#(7)$$

The time weight τ_k of each year is calculated based on the idea of "valuing the present while neglecting the past".

2.1.4. Static Logistics Capability

At each time, the optimal solution consists of the maximum value of each column element:

$$R^+(t_k) = (\max\{r_{11}(t_k), \cdots, r_{n1}(t_k)\}, \cdots, \max\{r_{1m}(t_k), \cdots, r_{nm}(t_k)\})$$

$$= \left(R_1^+(t_k), R_2^+(t_k), \cdots, R_m^+(t_k)\right)\#$$

The worst solution consists of the minimum value of each column:

$$R^-(t_k) = (\min\{r_{11}(t_k), \cdots, r_{n1}(t_k)\}, \cdots, \min\{r_{1m}(t_k), \cdots, r_{nm}(t_k)\}) = (R_1^-(t_k), R_2^-(t_k), \cdots, R_m^-(t_k))$$

Combined with the indicator weight $w_j(t_k)$, the closeness degree $C_i(t_k)$ of each evaluation object and the optimal scheme at each time is calculated. The closer $C_i(t_k)$ is to 1, the better the evaluation results.

$$D_i^+(t_k) = \sqrt{\sum_{j=1}^{m} w_j(t_k)\left(R_j^+(t_k) - r_{ij}(t_k)\right)^2} \#(8)$$

$$D_i^-(t_k) = \sqrt{\sum_{j=1}^{m} w_j(t_k)\left(R_j^-(t_k) - r_{ij}(t_k)\right)^2} \#(9)$$

$$C_i(t_k) = \frac{D_i^-(t_k)}{D_i^+(t_k)+D_I^-(t_k)}(0 \le C_i \le 1)\#(10)$$

2.1.5. Dynamic Comprehensive Logistics Capability

Combining the static evaluation result $C_i(t_k)$ and time weight τ_k, the result of formula (11) is the dynamic comprehensive evaluation result of logistics capacity.

$$s_i = \sum_{k=1}^{N} C_i(t_k) \cdot \tau_k, (k = 1,2,\cdots,N)\#(11)$$

2.1.6. Logistics Capability Evaluation Indicators

The evaluation standard of industry competitiveness has not yet been defined in a complete system all over the world. At present, Porter diamond model is the most common theory of industrial competitiveness. Porter believes that the competitiveness of a country's industry includes four decisive factors: production, demand, industry and enterprise. In addition, there are two auxiliary factors: government and opportunity. Under the background of globalization and the rise of the third industrial revolution, Mingjie Rui added the "knowledge absorption and innovation ability" element to the traditional diamond model, which made the diamond model more in line with the trend of the times and the national conditions of China [7].

Based on the diamond model, combined with the indicator system established by other scholars, according to the principles of scientificity, objectivity, operability and comparability, we put forward the following evaluation indicators of Logistics Competitiveness as Table 1.

Table 1: Indicator system of regional logistics capability

Factors	*Symbols*	*Standards*	*Units*
Production	X11	Number of Students per 100000 Population by Level	person
	X12	Number of Employed Persons in Transport	10 thousand people
	X13	Freight Traffic	10000 tons
	X14	Freight Ton-Kilometers	100 million t-km
	X15	Length of Transport Routes	km
Demand	X21	Gross Regional Product	100 million yuan
	X22	Household Consumption Expenditure	100 million yuan
	X23	Value-added in Transport Storage and Post	100 million yuan
	X24	Total Value of Imports and Exports	100 million yuan
Industry	X31	GRP of Tertiary Industry	100 million yuan
Enterprise	X41	Number of Legal Entities in Transport Storage and Post	unit
Government	X51	Fixed Assets in Transport Storage and Post	100 million yuan
	X52	Regional Government Expenditure	100 million yuan
Informationize	X61	Internet Penetration	%
	X62	Telephone Internet Penetration	unit/100 people
Knowledge	X71	Inventions	unit
	X72	Regional Government Expenditure in Scientific and Technological	100 million yuan

2.2 Logistics Efficiency Model

DEA is a method to analyze the comprehensive efficiency of decision making unit (DMU). The basic idea is to establish a linear programming model, provide input and output, and comprehensively analyze the ratio of input and output to obtain the comprehensive efficiency of each DMU. DEA avoids the influence of subjective factors and reduces the error to the greatest extent. It is one of the ideal comprehensive evaluation methods.

2.2.1. DEA basic model

The DEA with constant returns to scale is called CCR. CCR assumes that all the evaluated DMUs are in the stage of optimal production scale, but in actual production, many production units are not in the production state of optimal scale. Therefore, the technical efficiency obtained by CCR includes the component of scale efficiency, so it is usually called comprehensive technical efficiency. The DEA based on variable returns to scale is called BCC model. BCC adds convexity assumption to CCR, and technical efficiency excludes the influence of scale, so it is called pure technical efficiency. DEA is divided into input-oriented and output-oriented; the choice of input oriented model can control input factors more reasonably.

For DMUs, the corresponding input vector, output vector, input weight vector and output weight vector are marked as x_j, y_j, v, u:

$$x_j = \left(x_{1j}, x_{2j}, \dots, x_{mj}\right)^T > 0, \qquad (j = 1,2,\dots n)$$

$$y_j = \left(y_{1j}, y_{2j}, \dots, y_{sj}\right)^T > 0, \qquad (j = 1,2,\dots n)$$

$$\mathrm{v} = (v_1, v_2, \dots v_m)^T$$

$$\mathrm{u} = (u_1, u_2, \dots u_s)^T$$

The CCR is constructed, and its linear programming model is as follows. ForDMU$_{j0}$, the larger the h_{j0} , the higher the efficiency of DMU$_{j0}$.

$$\begin{cases} h_{j_0} = max\dfrac{u^T y_{j_0}}{v^T x_{j_0}} \\ \dfrac{u^T y_j}{v^T x_j} \le 1, j = 0,1,\dots,n \\ \mathrm{v} \ge 0, \mathrm{u} \ge 0 \end{cases} \#(12)$$

In this model, the duality theory of linear programming can be used to judge the effectiveness of DMU$_{j0}$. By introducing the relaxation variable s^+ and the residual variable s^-, the dual programming can be obtained as follows:

$$\begin{cases} \min\theta \\ \sum_{j=1}^{n} \lambda_j x_j + s^- = \theta x_0 \\ \sum_{j=1}^{n} \lambda_j y_j - s^+ = y_0 \\ \lambda_j \geq 0, s^- \geq 0, s^+ \geq 0 \end{cases} \# (13)$$

- If $\theta^* = 1$ and $s^- = s^+ = 0$, DMU is efficient.
- If $\theta^* = 1$ and $s^- > 0$ or $s^+ > 0$, DMU is weak efficient.
- If $\theta^* < 1$ and $s^- > 0$ or $s^+ > 0$, DMU is not efficient.

2.2.2. DEA-Malmquist

CCR and BBC can only compare the production efficiency of each DMU at a certain time. For panel data, Malmquist is usually used to calculate efficiency. The essence of Malmquist is to use the distance function (D) defined in DEA to measure the Change of Total Factor Productivity(TFPCH). TFPCH reflects the efficiency of DMU in a period of time.

$$\mathrm{TFPCH} = \mathrm{TECHCH} * \mathrm{EFFCH}$$

$$= \left[\left(\frac{D_{CCR}^{t}(x^{t+1},y^{t+1})}{D_{CCR}^{t+1}(x^{t+1},y^{t+1})}\right) * \left(\frac{D_{CCR}^{t}(x^{t},y^{t})}{D_{CCR}^{t+1}(x^{t},y^{t})}\right)\right]^{\frac{1}{2}} * \frac{D_{CCR}^{t+1}(x^{t+1},y^{t+1})}{D_{CCR}^{t}(x^{t},y^{t})} (14)$$

$$\mathrm{SECH} = \frac{D_{BCC}^{t}(x^{t},y^{t})/D_{CCR}^{t}(x^{t},y^{t})}{D_{BCC}^{t+1}(x^{t+1},y^{t+1})/D_{CCR}^{t+1}(x^{t+1},y^{t+1})} \#(15)$$

$$\mathrm{PECH} = \frac{D_{BCC}^{t+1}(x^{t+1},y^{t+1})}{D_{BBC}^{t}(x^{t},y^{t})} \#(16)$$

- Technology Change (TECHCH) greater than 1 means technology progress, less than 1 means technology retrogress.
- Efficiency Change (EFFCH) greater than 1 means efficiency progress, less than 1 means efficiency retrogress.
- Pure Technical Efficiency Change(PECH) greater than 1 means pure technical efficiency progress, less than 1 means pure technical efficiency retrogress.
- Scale Efficiency Change (SECH), greater than 1 indicates scale efficiency improvement; less than 1indicates scale efficiency retrogress.

2.2.3. Logistics Efficiency Evaluation Indicators

In order to analyze the efficiency of regional logistics, it is necessary to evaluate the relative efficiency of regional logistics industry through the input and output data of logistics industry in each province. DEA requires that the number of DMUs should be more than twice the sum of input and output indicators. The input indicators of logistics should be cost, reflecting the resources needed in the production process of logistics industry. The logistics output should be benefit, reflecting the production results of logistics industry.

According to the above requirements and indicators in Table 1, the input and output indicator system of regional logistics competitiveness is obtained, which was show in Table 2.

Table 2: Indicator system of regional logistics efficiency

Factors	*Symbols*	*Standards*	*Units*
Input	I1	Number of Employed Persons in Transport Storage and Post	10 thousand people
	I2	Length of Transport Routes	km
	I3	Fixed Assets in Transport Storage and Post	100 million yuan
Output	O1	Value-added in Transport Storage and Post	100 million yuan
	O2	Freight Traffic	10000 tons
	O3	Freight Ton-Kilometers	100 million t-km

2.3. Data Collection

The Belt and Road is China's cooperation with the relevant countries, which is a dual multilateral mechanism and an effective regional cooperation platform. The provinces along the Belt and Road are divided into five major regions as Table 3, and its functions include logistics and transportation. Logistics industry is an important industry to promote sustained and stable economic growth. With the continuous development of economy and the continuous progress of modern industry, in recent years, the logistics industry has been gradually valued. Evaluating five regions along the Belt and Road of the logistics competitiveness and putting forward suggestions are of great significance.

The evaluation dataset of this paper comes from China Statistical Yearbook, the National Bureau of statistics of the people's Republic of China, patent information service platform of key industries and so on.

Table 3: 5 regions and 18 provinces along the Belt and Road

Regions	*Provinces*
Northwest China	Xinjiang, Shaanxi, Gansu, Ningxia, Qinghai, Inner Mongolia
Northeast China	Heilongjiang, Jilin, Liaoning
Southwest China	Guangxi, Yunnan, Tibet
Coastal China	Shanghai, Fujian, Guangdong, Zhejiang, Hainan
Inland China	Chongqing

3. Results

3.1. Evaluation results of TOPSIS

According to the indicator system of regional logistics capability in Table 1 and the logistics capacity model based on improved TOPSIS, after the initial data is rewarded and punished by "development factor", the weight of each indicator from 2013 to 2017 are obtained according to the EW as shown in Table 4, and the time weight is shown in Table 5. The static evaluation results in Table 6 and Table 8 are brought into Formula (11) to calculate the dynamic comprehensive evaluation results. The comprehensive evaluation results are shown in Table 7 and Table 9.

Table 4: Weight of each indicator in 2013-2017

Indicators	*2013*	*2014*	*2015*	*2016*	*2017*
X11	0.024	0.022	0.022	0.021	0.023
X12	0.044	0.047	0.042	0.042	0.04
X13	0.046	0.044	0.041	0.042	0.041
X14	0.067	0.075	0.075	0.082	0.083

X15	0.03	0.029	0.027	0.026	0.025
X21	0.055	0.056	0.056	0.056	0.057
X22	0.036	0.037	0.038	0.038	0.038
X23	0.052	0.052	0.052	0.05	0.049
X23	0.162	0.156	0.156	0.159	0.144
X31	0.067	0.065	0.063	0.062	0.062
X41	0.067	0.064	0.058	0.053	0.052
X51	0.049	0.045	0.042	0.044	0.043
X52	0.044	0.043	0.049	0.045	0.048
X61	0.039	0.041	0.034	0.031	0.034
X62	0.028	0.038	0.038	0.029	0.032
X71	0.099	0.101	0.101	0.102	0.108
X72	0.092	0.086	0.109	0.119	0.121

Table 5: Time weight in 2013-2017

	2013	*2014*	*2015*	*2016*	*2017*
Weight	0.067	0.133	0.2	0.267	0.333

Table 6: Static logistics capacity of provinces in 2013-2017

Provinces	*2013*	*2014*	*2015*	*2016*	*2017*
	Value	*Value*	*Value*	*Value*	*Value*
Inner Mongolia	0.284	0.275	0.239	0.252	0.229
Liaoning	0.438	0.42	0.367	0.324	0.306
Jilin	0.193	0.197	0.184	0.186	0.181
Heilongjiang	0.22	0.216	0.203	0.198	0.188
Shanghai	0.537	0.557	0.509	0.52	0.511
Zhejiang	0.568	0.588	0.55	0.534	0.529
Fujian	0.341	0.357	0.359	0.346	0.334
Guangdong	0.836	0.861	0.864	0.884	0.876
Guangxi	0.225	0.229	0.212	0.223	0.211
Hainan	0.123	0.124	0.13	0.121	0.118
Chongqing	0.241	0.259	0.251	0.246	0.248
Yunnan	0.225	0.234	0.215	0.252	0.251
Tibet	0.068	0.069	0.068	0.068	0.056
Shaanxi	0.275	0.275	0.269	0.265	0.266
Gansu	0.145	0.146	0.135	0.141	0.131
Qinghai	0.112	0.111	0.113	0.102	0.108
Ningxia	0.116	0.12	0.111	0.117	0.117
Xinjiang	0.201	0.199	0.193	0.179	0.202

Table 7: Dynamic logistics capacity of provinces in 2013-2017

Provinces	*Value*	*Rank*
Guangdong	0.871	1
Zhejiang	0.545	2
Shanghai	0.521	3
Liaoning	0.347	4
Fujian	0.346	5
Shanxi	0.268	6
Chongqing	0.249	7
Inner Mongolia	0.247	8
Yunnan	0.24	9
Guangxi	0.218	10
Heilongjiang	0.2	11
Xinjiang	0.194	12
Jilin	0.186	13
Gansu	0.137	14
Hainan	0.122	15
Ningxia	0.116	16
Qinghai	0.108	17
Tibet	0.064	18

Table 8: Static logistics capacity of regions in 2013-2017

Regions	*2013*	*2014*	*2015*	*2016*	*2017*
	Value	*Value*	*Value*	*Value*	*Value*
Northwest China	0.189	0.188	0.177	0.176	0.176
Northeast China	0.284	0.278	0.251	0.236	0.225
Southwest China	0.173	0.177	0.165	0.181	0.173
Coastal China	0.481	0.497	0.482	0.481	0.474
Inland China	0.241	0.259	0.251	0.246	0.248

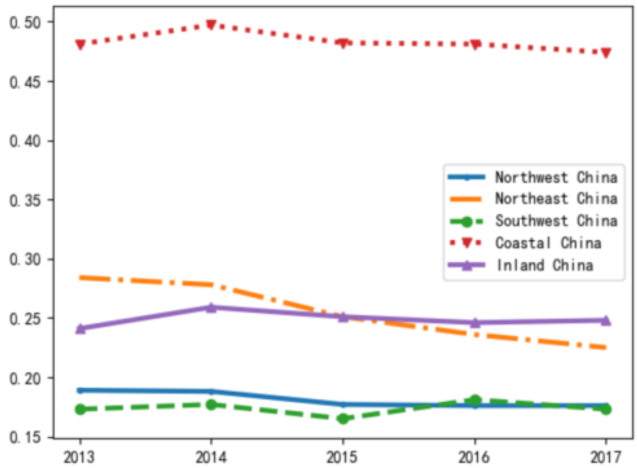

Figure 2: Logistics capacity trend of regions in 2013-2017

Table 9: Dynamic logistics capacity of regions in 2013-2017

Regions	Value	Rank
Coastal China	0.481	1
Inland China	0.249	2
Northeast China	0.244	3
Northwest China	0.178	4
Southwest China	0.174	5

3.2. Evaluation results of DEA

According to the indicators in Table 2, the efficiency of each DMU is calculated and shown as Table 10 - Table 13.

Table 10: Static logistics efficiency of provinces in 2013-2017

Provinces	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*
	TFPCH	*TFPCH*	*TFPCH*	*TFPCH*
Inner Mongolia	1.03	0.90	0.943	1.116
Liaoning	1.03	1.047	1.311	1.09
Jilin	0.909	0.944	0.99	1.055
Heilongjiang	0.952	0.806	1.04	1.036
Shanghai	1.206	0.8	0.956	1.177
Zhejiang	1.004	1.05	1.058	1.076
Fujian	1.097	1.102	1.092	1.067
Guangdong	1.024	0.995	1.092	1.036
Guangxi	1.056	0.913	1.063	1.078
Hainan	1.526	0.707	0.933	1.183
Chongqing	0.98	1.005	1.076	1.016
Yunnan	1.022	0.99	1.062	1.085
Tibet	0.824	1.059	1.052	1.054
Shanxi	1.029	0.669	1.028	1.076
Gansu	1.051	0.915	0.98	1.069
Qinghai	1.3	0.931	1.06	0.986
Ningxia	0.845	0.929	0.947	0.922
Xinjiang	1.023	0.953	1.129	0.893

Table 11: Dynamic logistics efficiency of provinces in 2013-2017

Provinces	*EFFCH*	*TECHCH*	*PECH*	*SECH*	*TFPCH*	*Rank*
Liaoning	1	1.114	1	1	1.114	1
Fujian	1	1.089	1	1	1.089	2
Qinghai	1.039	1.021	1.05	0.99	1.061	3
Zhejiang	1	1.047	1	1	1.047	4
Hainan	1.014	1.03	1	1.01	1.044	5
Yunnan	1.04	0.999	0.97	1.07	1.039	6
Guangdong	1.018	1.017	1	1.02	1.036	7
Guangxi	1.039	0.987	1	1.04	1.026	8
Shanghai	1	1.021	1	1	1.021	9
Chongqing	1.013	1.005	0.99	1.02	1.019	10
Gansu	0.981	1.021	0.97	1.01	1.002	11
Xinjiang	1.063	0.937	0.98	1.09	0.996	12
Inner Mongolia	1	0.992	1	1	0.992	13
Tibet	0.924	1.074	1	0.92	0.992	13
Jilin	0.985	0.988	0.97	1.02	0.973	15
Heilongjiang	0.966	0.987	0.94	1.03	0.953	16
Shanxi	1.039	0.899	0.92	1.13	0.934	17
Ningxia	1	0.91	1	1	0.91	18

Table 12: Static logistics efficiency of regions in 2013-2017

Region	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*
	TFPCH	*TFPCH*	*TFPCH*	*TFPCH*
Northwest China	1.046	0.882	1.015	1.01
Northeast China	0.964	0.932	1.114	1.06
Southwest China	0.967	0.987	1.059	1.072
Coastal China	1.171	0.931	1.026	1.108
Inland China	0.98	1.005	1.076	1.016

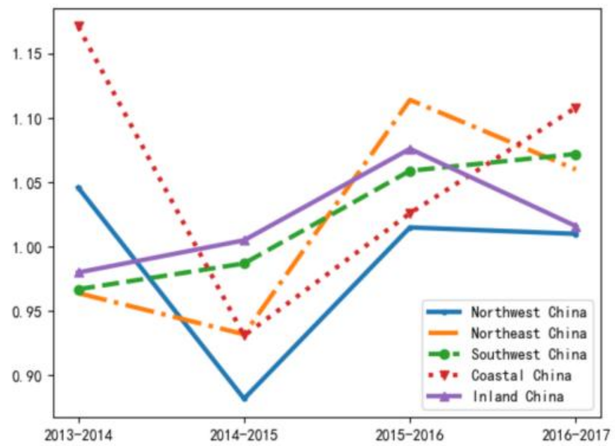

Figure 3: Logistics efficiency trend of regions in 2013-2017

Table 13: Dynamic logistics efficiency of regions in 2013-2017

Region	*EFFCH*	*TECHCH*	*PECH*	*SECH*	*TFPCH*	*Rank*
Coastal China	1.006	1.041	1	1.01	1.047	1
Southwest China	1.001	1.02	0.99	1.01	1.019	2
Inland China	1.013	1.005	0.99	1.02	1.019	2
Northeast China	0.984	1.03	0.97	1.02	1.013	4
Northwest China	1.02	0.963	0.97	1.04	0.983	5

3.3. Evaluation results of Topsis-DEA model

According to the results of Table 7, Table 9, Table 11 and Table 13, 0.3 is selected as the TOPSIS-axis demarcation line, and 1 is selected as the DEA-axis demarcation line. The evaluation results of TOPSIS-DEA model are drawn in the TOPSIS-DEA coordinate department. The distribution of logistics competitiveness of provinces and regions is shown in Figure 4, and the evaluation results are basically consistent with the reality.

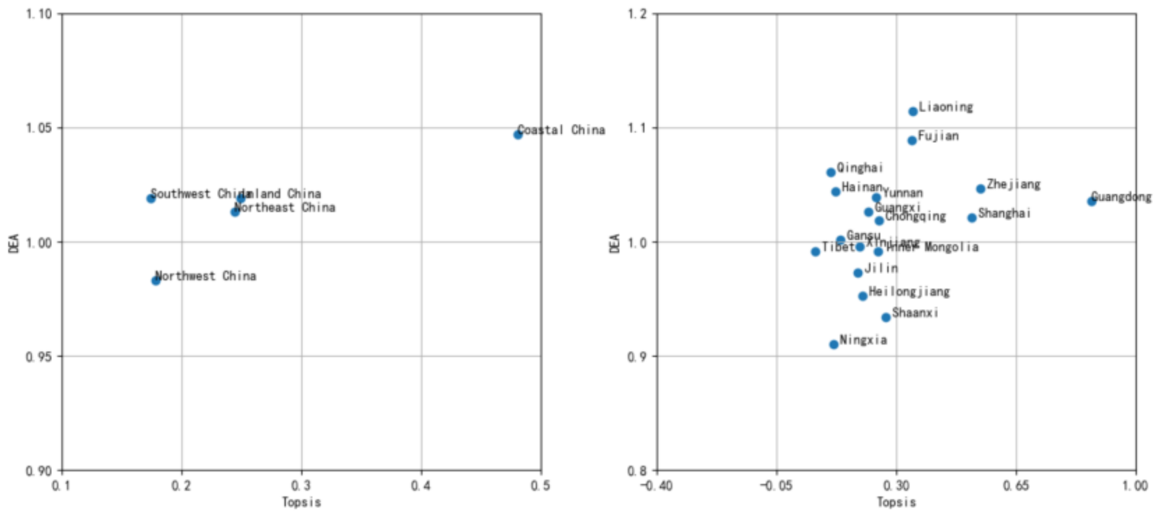

Figure 4: Dynamic comprehensive evaluation of TOPSIS-DEA model

4. Discussion

It can be seen from Table 9 that the rank of logistics capacity is Coastal China, Inland China, Northeast China, Northwest China and Southwest China. The logistics capacity evaluation result of Coastal China is far higher than other regions. It can be seen from Table 8 and Figure 2 that the logistics capacity of Coastal China always regions ranks first. The logistics capacity of Northeast China decreases year by year, while the logistics capacity of Inland China increases year by year, then Inland China surpass Northeast China in 2016. The logistics capacity of Northwest China and Southwest China has always been a low level. From Table 13 and figure 3, we can see that the rank of logistics efficiency is Coastal China, Southwest China, Inland China, Northeast China and Northwest China. The TFPCH of Coastal China is 1.047, which shows that the average annual growth rate of TFPCH in Coastal China is 4.7%.The TFPCH of Northwest China is 0.983, which shows that the average annual decrease rate of TFPCH in Northwest China is 1.7%. The TECHCH and EFFCH of Coastal China, Southwest China and Inland China are in growth state, but SECH in Southwest China and Inland China decreases slightly. EFFCH in Northeast China is in a declining state, which is mainly caused by the decline of PECH; TFPCH of Northwest China shows a downward trend. Coastal China has stronger logistics capability and higher logistics efficiency, the logistics capability of Southwest China, Inland China and Northeast China is weak, but the logistics efficiency is relatively high, the logistics capability of Northwest China is weak, meanwhile its logistics efficiency is low.

Coastal China are important platforms for leading international cooperation and competition, while giving full play to the advantages of Guangdong-Hong Kong-Macao Greater Bay Area. Itis located in coastal areas, its terrain is mostly plain, which has unique advantages in location. In addition, it has active logistics demand, developing economy, huge foreign trade and domestic trade volume. Government supports logistics industry and attaches importance to logistics industry, so infrastructure construction level is high, which can attract a large number of related industries and enterprises. Meanwhile, it has developed economy, high level of informatization and innovation; further promote the development of logistics industry.

Northwest China is an important platform for deepening exchanges and cooperation with Central Asia, South Asia and West Asia. Northeast China is an important hub for strengthening the connection with Russia and Mongolia, Southwest China is the radiation center facing ASEAN, South Asia and Southeast Asia, and Inland China is the transportation channel connecting Europe, meanwhile it is the transportation hub connecting all over China. According to Figure 4, compared with Coastal China, the logistics capacity and efficiency of these regions are relatively backward. First of all, there are disadvantages in the geographical location of these regions. Meanwhile, the logistics infrastructure is relatively backward, which further leads to the backwardness of the logistics industry. Therefore, we should increase the economic support for the logistics industry, increase the investment in infrastructure, improve the urban transportation network, and develop its own logistics industry characteristics. Secondly, the economy of these regions is relatively backward, and the logistics industry is in the developing stage, so it is unable to attract talents. In addition, the logistics innovation level is poor and the informatization level is low. Many enterprises only rely on manual operation, which will make the logistics industry more unattractive and cause a large number of brain drain. Therefore, we should seize the opportunity, strengthen the subsidy of logistics talents, attract more logistics talents, encourage scientific and technological innovation, develop high-end logistics industry with high scientific and technological content and strong technological innovation, introduce and develop advanced technologies such as Radio Frequency Identification and Unmanned Aerial Vehicle, increase the investment in high-tech, enhance the innovation force of system and management, and promote the industrial progress with high-tech. Finally, the logistics system in these regions is not perfect, the logistics industry management is chaotic, and the logistics industry is not paid attention to, which leads to the slow growth rate and backward ability of the logistics industry. As an important tertiary industry, the logistics industry plays a very important role in economic growth and urban development. Therefore, the government should establish a perfect logistics management system and policies, increase policy support for the logistics industry, actively find problems in the development of the logistics industry, and make timely adjustments and improvements, vigorously promote the transformation of the logistics industry, and transform "investment driven progress" into "management and innovation drive progress".

5. Conclusion

In this paper, the logistics competitiveness is divided into two aspects: logistics capacity and logistics efficiency, and a dynamic comprehensive evaluation model of logistics competitiveness is constructed. This model overcomes the shortcomings of the traditional static logistics competitiveness evaluation models based on cross-section data, and proposes a dynamic evaluation model based on panel data. In the evaluation of logistics capability, an improved TOPSIS based on "development factor" and quadratic weighting method is proposed to evaluate and rank the logistics capacity. DEA-malmquis is used to evaluate and rank the logistics efficiency. Finally, the evaluation results of TOPSIS-DEA model are drawn in the two-dimensional coordinate department of logistics capacity-efficiency, which has good application value.

On the other hand, we still have some improvements. The data we selected cover less years. In future studies, we will add more data.

References

[1] Li F, Peng H P. Evaluation on the competitiveness of regional logistics industry in the Silk Road Economic Belt. Journal of Xi'an University of Finance and Economics 2018, 03, 99-103.

[2] Zhang Y, Zhao G. Comprehensive evaluation system of Port Logistics Competitiveness Based on fuzzy comprehensive evaluation method. Market weekly (Theoretical Research) 2007, 04, 38-39.

[3] Yang Y C, Chen S L. Determinants of global logistics hub ports: Comparison of the port development policiesb of Taiwan, Korea, and Japan. Transport Policy 2016, 45, 179-189.
[4] Wang W G, Ma Y Y. Efficiency of regional logistics industry in China: Malmquist Luenberger index method based on three stage DEA model. Systems engineering 2012, 03, 66-75.
[5] Fan Y, Ma L m. Research on regional logistics efficiency in China based on SFA. Business times 2011, 72, 39-43.
[6] Hong S Q, Zhang Q J. Analysis of Development Status and Efficiency of Logistics Industry in the Pearl RiverBased on Delta in the Context of China-US Trade War by the DEA-ANN Model. 2019 15th InternationalConference on Computational Intelligence and Security (CIS); Macao, China, 2019; pp. 1-5.
[7] Yi P T, Zhou Y, Guo Y J, Li W W. A dynamic comprehensive evaluation method reflecting the developmenttrend. Operation research and management 2016, 6, 175-180.
[8] Derek D. Wang: Performance assessment of major global cities by DEA and Malmquist index analysis. Computers, Environment and Urban Systems 2019, 77.
[9] Rouyendegh, B.D., Yildizbasi, A. & Yilmaz, I. Evaluation of retail industry performance ability through integrated intuitionistic fuzzy TOPSIS and data envelopment analysis approach. Computers, Environment and Urban Systems 2020, 24, 12255–12266.
[10] Liu Z, Mao M, Tan W, Zhang M and Zhong W. Evaluation of Urban Logistics Competitiveness in Jiangxi Province Using Entropy Weighted TOPSIS. 2019 IEEE 14th International Conference on Intelligent Systems and Knowledge Engineering (ISKE); Dalian, China, 2019; pp. 805-810.
[11] Kim, C.; Kim, H.; Choi, K. Efficiency Analysis of Public Library Services Based on Establishing Entity and Outsourcing. Sustainability 2020, 12, 9205.
[12] Sevinç, A.; Eren, T. Determination of KOSGEB Support Models for Small- and Medium-Scale Enterprises by Means of Data Envelopment Analysis and Multi-Criteria Decision Making Methods. Processes 2019, 7, 130.
[13] Wang Y R, Ren L R, Chen L W, Sun Z Q. A new improved TOPSIS method and its medical application. Journal of Central South University (Medical Edition) 2013, 2, 196-201.
[14] Li, Y.; Shao, S.; Zhang, F. An Analysis of the Multi-Criteria Decision-Making Problem for Distributed Energy Systems. Energies 2018, 11, 2453.
[15] Sevinç, A.; Eren, T. Determination of KOSGEB Support Models for Small- and Medium-Scale Enterprises byMeans of Data Envelopment Analysis and Multi-Criteria Decision Making Methods. Processes 2019, 7, 130.
[16] Fu C W, Zhang W F. Research on total factor productivity of Public Library Industry: an analysis of DEAMalmquist model based on Provincial Panel Data. Journal of central China Normal University (Humanities and Social Sciences) 2018, 3, 81-89.
[17] Du, T. Performance Measurement of Healthcare Service and Association Discussion between Quality andEfficiency: Evidence from 31 Provinces of Mainland China. Sustainability 2018, 10, 74.