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The Effectiveness Analysis of Logistics Development in Inner Mongolia Cities ----Based on DEA Model

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Abstract: *Logistics efficiency is an important measurement of logistics industry development.[1] Through setting up the logistics input and output indicator, we static test 12 cities of Inner Mongolia logistics industry development, by analyzing overall efficiency, technical efficiency and economics of scale. We provide quantitative analysis gist for Inner Mongolia logistic industry development.*

Keywords: *Data envelopment analysis, effectiveness, distortion analysis*

1. INTRODUCTION

Logistics industry is the product of socialize great production and industrial professionalization, the development level of which is also a significant measurement of nationwide modernization and economy overall competitive ability. Evaluating modern logistics development level in the area scientifically, means a lot in making scientific decision, improve modern economy development circumstance hence increase competitive ability[1].

Aiming at analyzing and estimating regional logistics development and overall competitive objective accurately, we make logistics strategy plan and raise the effectiveness evaluation of Inner Mongolia logistics development, based on DEA analysis. In order to make the logistics plan come out a better result, we need to solve two problems: (1) Finding out the choke point of logistics development between cities (2) Ranking the cities logistics development. Therefore, in this essay, we use DEA method, constructing input and output ratio to evaluate each city's logistics development efficiency. At last, we analyze the differences and causes, so as we can find problems and solutions.

2. DEA EFFECTIVENESS EVALUATION MODEL

2.1. Research on Regional Logistics Development Measurement

Peng Jian(2011) uses fuzzy matter-element method, researching on economy growth and logistic ability support of 31 provinces[2]. Liu Lin(2012) and his colleagues raise the concept of regional logistic ability, they use the provinces panel data empirically analyze the relationships of regional logistics resources, regional logistics efficiency and economic growth[3]. Xu Qian(2011) and her colleague use freight turnover, passenger turnover as regional logistics capability indicators, analyzing the relations between logistics and economy in Zhejiang province, thus verifying significant correlation between the two factors[4]. Ni Ming(2015) founds regional logistics efficiency evaluation index system of input-output, in the case of Jiangxi Province, and applying the DEA model of its 2005--2013 logistics efficiency evaluation[5].Hongmei He(2012) holds the opinion that the market,

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transport facilities, information technology are the external causes of logistics efficiency, while logistics centers and operating cost are the internal causes [6]. Merkert R (2014) analyzes the logistics situation in remote areas, noting that we should improve logistics and transport efficiency in remote areas and consider more about the utilization of infrastructure[7]. According to the above reference, when we use DEA model to study Multiple Input Multiple Output (MIMO) theory, the pre-estimate parameters are not needed, which means the model has superiority in avoiding subjective factors, simplifying operations and reducing errors. So we use DEA method to evaluate the effectiveness of Inner Mongolia logistics development.

2.2. DEA Model and Method Analysis

Data envelopment analysis is raised by the famous American operational research experts, A. Charnes[8]. It's a efficiency evaluation method based on the "relatively efficient evaluation" concept. It takes each evaluated unit or department as a decision-making unit (DMU), decision-making unit section(DMUS) founds the evaluation groups. Each DMU is required to have the same input and output. We can obtain the relative effectiveness of each DMU efficiency after we analyze input and output data. Furthermore we can note that other non-effective DMU causes and extent, while also using the projection method to indicate improvement direction.

C^2R is the model of determining overall decision-making unit efficiency, which is the product of technical efficiency and scale efficiency. If the DMU is effective in C^2R model, it represents technology and scale level are also effective.

C^2R model of DEA Method: Based on the ordinary axiom, convexity axiom, invalidity axiom, axiom and minimum cone axiom is assumed, a production possibility set:

$$T_{C^2R}=\{(X,Y)\,|\,\sum_{j=1}^{n}\lambda_j X_j \le X,\sum_{j=1}^{n}\lambda_j Y_j \ge Y,\ \lambda_j \ge 0,\ j=1,2,\cdots,n\}$$

DEA model can be obtained as follows:

$$(D^I_{C^2R})\begin{cases}\min\ \theta\\ \sum_{j=1}^{n}\lambda_j X_j + S^- = \theta X_0\\ \sum_{j=1}^{n}\lambda_j Y_j - S^+ = Y_0\\ \lambda_j \ge 0,\ j=1,2,\cdots,n\\ S^- \ge 0,\ S^+ \ge 0\end{cases}$$

N represents the number of the same kind decision making units; θ is logistics development effectiveness evaluation value; x is the input index, y is the output index; λ is the input variable coefficients, s^- is the remaining variables, s^+ is slack variables.

The optimal solution is:

(1) θ=1, s^{-0} =0 , s^{+0} =0 ,we say the decision unit is DEA valid. The obtained output on the basis of the original input has been optimal, which is both technology effective, and scale valid.

(2) θ=1, 且s^{-0}≠0, s^{+0}≠0,we say the decision unit is weak DEA efficient. The original input can be reduced while maintaining the original s- output unchanged, or increase the output of s + while maintaining input unchanged.

(3) θ <1, we say the decision unit is DEA invalid. λj connects the effective dots so that each form an effective frontier. Non-zero s-0、s+0 make the effective frontier extend in horizontal and vertical directions, thus forming envelope. In practice, the study of non-zero slack variable is significant as it is a "pure" excess amount (s-0) or less than the amount (s + 0). θ indicates the distance of DMU from the efficient frontier surface or envelope surface of a radial distance or amount of optimization.

3. EMPIRICAL ANALYSIS

3.1. Selection of DMU and Evaluation Index System

In order to reflect the logistics development situation of Inner Mongolia, we select 12 cities as 12 policy unit. On the basis of analyzing city logistics performance evaluation literature, and in accordance with the development of the logistics industry in the Union City's different conditions and characteristics, we combine the scientific indicators, representativeness and availability principle. In the essay we select the highway mileage (km), transport of goods and motor insurance expenditure (million), number of employees and logistics for the input variables. Union City GDP (billion), the tertiary industry GDP (billion), goods turnover (million tons) as the output variable[9-11], we use DEA method evaluate Inner Mongolia logistics industry development. Data is from the 2015 "Statistical Yearbook of Inner Mongolia Autonomous Region". Grade highway mileage can replace the logistics infrastructure investment, transport of goods and motor insurance expenses reflect the scale of main transportation of city logistics to some extent, the tertiary industry staff number reflects the number of logistics industry employees. The overall GDP level of logistics development connects closely with complement GDP. The tertiary industry output value is approximate the same as logistics industry overall output. Logistics and transport goods turnover reflects the results of logistics the completed by road transportation.

3.2. DEA Data Analysis

According to statistical data, we use DEAP 2．1 software calculate 12 cities of Inner Mongolia logistic efficiency evaluation.

Efficiency value is showed in Table3.1

Table 3.1 DEA efficiency and scale efficiency

DMU	crste	vrste	scale	return to scale
Hohhot	1	1	1	-
Baotou	1	1	1	-
Hulunbeir	0.865	0.953	0.908	drs
Xingan League	1	1	1	-
Tongliao	1	1	1	-
Chifeng	0.658	0.674	0.976	irs
Xilinguole League	1	1	1	-
Ulan Qab	0.782	0.829	0.944	irs
Erdos	1	1	1	-
Bayinnaoer	1	1	1	-
Wuhai	1	1	1	-
Alxa League	1	1	1	-
mean value	0.922	0.934	0.987	

(1) Technical Efficiency and Pure Technical Efficiency Analysis of 2015

From table 3.1, we can know that 9 cities of which the technical efficiency and pure technical efficiency equal to 1, achieve optimal in logistics input elements, thus indicates DEA efficient. And the other 3 cities overall efficiency values are less than 1, which indicates DEA inefficiency. We have logistics resources redundancy issue in different degree.To achieve DEA model C^2R efficient, we need

to adjust from various aspects. From overall efficiency and pure technical efficiency perspective, Chifeng is the lowest, and in need of resources relocation improvement. UlanQab has low total GDP, its economic development is also slow, we need enhance infrastructure construction and complete logistics network.

(2) Scale Efficiency Analysis of 2015

Chifeng and Ulan Qab have increasing economies of scale, logistics elements investment should be increased, to achieve economies of scale. Hulun Beir economies of scale is decreasing, indicating input-output ratio is not optimal, logistics scale has reached saturation point. With the investment increasing and output value decreasing, logistics investment should be reduced.

3.3. Projection Analysis

We use DEAP2.1 software to do the "projection" analysis, which helps us identify the direction of non-DEA efficient DMU and its optimization direction, notes that effective frontier logistics development. Results for "projection" analysis are shown in Table 3.2

Table3.2. *The projection results*

Index	Original value	Projected value	Original value	Projected value	Original value	Projected value
	Hulunbeir	Hulunbeir	Chifeng	Chifeng	Ulan Qab	Ulan Qab
GDP (billion yuan)	1522.2	1891.951	1778.37	1795.521	873.73	1002.624
Gross National Product of Tertiary Industr (billion yuan)	566.44	663.192	644.28	737.747	307.13	353.664
tonnage mileage(10000 t·km)	1711322	1711322	2398284	2398284	1172516	1172516
highway mileage(km)	22249	17917.737	24893	15551.252	13383	11088.852
Cargo transport and vehicle insurance (10000 yuan)	36	34.32	117	78.838	42	34.8
logistics professionals	639700	523808.483	711900	479700.73	349000	289173.539

We can see from projection measurement analysis results, for non-DEA efficient DMU adjusted to DEA effective, the investment value is large, especially in Chifeng, which indicates part of the investment scale is too large in Inner Mongolia logistics industry. The DEA invalid reason of the 3 cities is as follow: Logistic transport roads and transportations are not well used, the number of logistics industry staff is large but quality is low. Overall logistics resources are in wasted state. Therefore, under the circumstance of existing logistics resources well relocated, the logistics industry has a great potential.

From the perspective of output, three cities' GDP and tertiary industry GDP are low, which indicates we should pay more attention to economic investment benefits, so as to stimulate economic growth, make logistics and urban economic activities complement each other, and achieve coordinated development of logistics.

4. CONCLUSION

We can draw the conclusion that DEA model is effective way to evaluate and analyze cities logistics efficiency through empirical analysis. By means of determining logistics development effective leading surface as well as nullity units projection analysis, we can confirm the extent of improvement and adjustment.

Considering empirical results and logistics industry current research, we can give the recommendations. Inner Mongolia logistics industry is in the development stage, the three cities' main

task should be overall planning, optimizing the allocation of logistics resources, using existing hardware foundation construction strengthen software construction, reducing waste of resources. We should be more targeted rather than expanding highways blindly. Keeping focus on improving the efficiency of freight cars rather than unduly increase the size of freight cars. What's more, we should enhance the post-training of logistics staff, introduce high-precision logistics talents. By those means we can increase GDP, improve logistics efficiency, thereby promotes economic development.

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