Research on Science and Technology Innovation Resource Allocation Efficiency in China's Logistics Industry—Based on the Empirical Analysis of the Output-oriented SBM Model

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Abstract

This paper applies a more realistic output-oriented SBM model to estimate the allocation efficiency of scientific and technological innovation resources of logistics industry in 30 provinces of China from 2014 to 2016. The result indicates that the overall efficiency of scientific and technological innovation resource allocation in logistics industry by 30 provinces is low, mainly due to the inefficiency of pure technology restricts the optimization of the allocation efficiency of resources, differences among regions is significant, and some provinces have key problems of Inputs redundancy and outputs insufficient.

Keywords

Output-oriented SBM model; Science and technology innovation; logistics industry; Resource allocation efficiency.

1. Introduction

Logistics science and technology innovation is the core of the development of modern logistics industry, which can promote the construction of efficient and orderly logistics system, accelerate the rapid upgrading of the entire logistics management level, realize the integration of industrial chain and the process optimization of logistics resource integration[1].In 2014, the Medium and Long-Term Plan for Logistics Industry Development (2014-2020) clearly stated: “Strengthen the core technology and equipment research and development of logistics, promote the industrialization of key technical equipment, and absorb the introduction of international advanced logistics technology to improve the independent innovation capability of logistics technology. "In 2016, the National Development and Reform Commission issued the "Opinions on the Implementation of "Internet +" Efficient Logistics" (hereinafter referred to as "Opinions"). The opinions pointed out: "Adhering to the new trend of science and technology and industrial development in the field of logistics, promoting the efficient "Internet +" logistics and The combination of mass entrepreneurship and innovation is innovating, innovating the allocation of logistics resources, greatly improving the efficiency of logistics efficiency, and realizing the transformation and upgrading of the logistics industry.” As of January 23, 2018, the State Council issued the “Opinions on Promoting the Coordinated Development of E-Commerce and Express Logistics” It also pointed out: "Strengthen the application of modern information technology and equipment such as big data, cloud computing and robots in the field of express logistics, improve the level of scientific and technological application, and strive to achieve information synergy and intelligent service." This shows that the Chinese government's logistics science and technology innovation The emphasis on work has become increasingly prominent, with the aim of achieving Flow scientific and technological achievements into practical productive forces, enhance independent innovation capability industry. Logistics science and technology innovation is also the process of optimizing and integrating innovation resources such as manpower, material resources, finance, technology and information. Considering the scarcity and limited nature of innovation resources, it is necessary to fully coordinate the proportion of resources in science and technology innovation, and then improve logistics technology. Innovative resource allocation efficiency. Therefore, how to optimize the resource allocation structure of science and technology innovation is particularly important under the innovation-driven development strategy. It is of great theoretical and practical significance to make up for the short-board problem of the industry and to achieve cost reduction and efficiency enhancement.

At present, domestic scholars mainly discuss the logistics innovation system and efficiency from the meso-level or micro-level of enterprises, and less on the macro-level and resource allocation research. Deng Hengjin (2012) solved the important and urgent problems faced in the process of regional logistics system upgrading by constructing the logical model of "regional logistics innovation system" and proposing application ideas[2]. Yu Wenqiang (2016) analyzed the factors affecting the transformation and upgrading results and efficiency by establishing an innovation-oriented logistics enterprise transformation and upgrading model[3]. Li Shoulin et al. (2018) used the DEA method to analyze the innovation efficiency of 11 logistics listed companies from 2014 to 2016, and proposed to improve the efficiency of logistics listed enterprises from three aspects: internal technology investment, management level and internal synergy[4]. Foreign scholars often discuss the impact and role of innovation on the development of the logistics industry from different angles. Sarminah Samad (2012), based on sample data from 150 managers of Malaysian logistics companies, found that transformational leadership and innovation significantly improved the organizational performance of logistics companies, and the fascinating characteristics of transformational leadership and products and services in innovation are affecting logistics. An important factor in organizational performance[5]. Marcella De Martino et al. (2013) aim to focus on the role of inter-organizational relationships in seaport innovation, applying logistics innovation theory to seaports for deduction and summarizing the specific case of seaports that achieve logistics innovation[6]. A study by Peter V. Hall (2013) found that despite the strong demand and supply of innovation in the West Coast ports of the United States, the complex dynamics of the logistics chain make successful innovation require the conscious participation and collaboration of stakeholders[7]. Wai Peng Wong et al. (2016) used the data envelopment of the three dimensions of innovative components to analyze the Malmquist index method to assess the impact of innovation on third-party logistics, and for the first time applied the all-factor productivity enhancement method with innovative components to the logistics industry. Considering that productivity and innovation discoveries provide enlightenment for the development of the Malaysian logistics industry[8].

Throughout the above research results, scholars have not yet carried out research on the allocation of scientific and technological innovation resources in the logistics industry, still staying at the theoretical level of logistics innovation, but neglecting the resource allocation structure in the process of technological innovation. The optimal allocation of scientific and technological innovation resources is the key way to transform the traditional logistics industry into the modern logistics industry. Based on this, this paper takes the industry panel data of 30 provinces in 2014-2016 as a sample, and uses the output-oriented SBM model to measure the logistics industry technology. Innovate resource allocation levels and compare resource allocation efficiency differences across regions.

2. Construction of Output-oriented SBM Model

Data Envelopment Analysis (DEA) was first proposed by Charnes and Cooper et al. in 1978 to evaluate decision-making units (DMUs) with multiple inputs and multiple outputs using a mathematical programming model [9]. The non-parametric statistical method of relative effectiveness (DEA effective) is essentially to determine whether the DMU is located on the "frontier" of the production set. Compared to other parametric methods, the nonparametric DEA method does not utilize any functional form assumptions and is not subject to the potential distribution of error terms [10]. In the DEA method, CCR is the most basic, most important and the earliest efficiency evaluation model, and has been widely used.

There are two basic methods for measuring DMU efficiency in the DEA model: radial and non-radial [11]. Radial models (such as CCR) tend to ignore the problem of non-radial slack, and the efficiency score may be misleading when used as the only indicator to evaluate the performance of the decision-making unit. To this end, Kaoru Tone prototyped the radial CCR model and the BCC model. In 2001, the non-radial SBM model was created. By introducing the slack variable directly into the objective function, the measure satisfies the unit invariance and monotonicity of relaxation. Thereby effectively solving the problem of input and output slack [12]. In addition to directly interpreting the input and output relaxation in the efficiency measure, the SBM model has the advantage of capturing the entire inefficient feature and is able to minimize the objective function with the maximum amount of slack[13]. The basic principle is to assume that there are n decision units (DMUs), the decision units to be evaluated are recorded as $DMU_j(j=1,2,\cdots n)$, and each DMU can use m inputs $x_i(i=1,2\cdots,m)$ to produce s outputs $r(r=1,2,\cdots s)$. In view of the fact that the setting of the input-oriented model is contrary to the fact that China's R&D investment is far lower than that of the developed countries, the output-oriented model ensures that the output is expanded under the premise of the existing investment, which is in line with the current R&D investment situation in China [14]. Therefore, this paper intends to construct an Output-oriented SBM Model:

$$\rho_o^* = \min_{\lambda_j, s^+, s^-} \frac{1}{1+\frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{r0}}$$

$$s.t. \sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{i0}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0}$$

$$\lambda_j \geq 0, s_r^+ \geq 0, s_i^- \geq 0$$

In the formula, the objective function ρ_o^* is the efficiency value of the decision-making unit, representing the weight coefficients, λ_j represents the weight coefficient corresponding to the j-th decision-making unit, x_{ij} , y_{rj} represent the i-th input and the r-th output of the j-th decision-making unit, The relaxation of input and output of the evaluated decision-making unit is reflected by s_r^+ and s_i^- respectively.

3. Establishment of Evaluation Index System and Data Sources

Science and technology innovation resources include human, financial, material, technology and information. In view of the fact that there is no "logistics industry" in the classification of industrial systems in various countries, the proportion of added value of transportation, warehousing and postal industry to added value of logistics industry in past years is over 80%, which can approximately reflect the level of development of logistics industry[15].Therefore, in terms of investment in science and technology, the total investment in transportation research projects and the financial expenditures of transportation are selected as the human and financial resources for logistics technology innovation, and the logistics industry in China is measured by the fixed assets investment in transportation, warehousing and postal industry. In the process of physical input, the actual expenditure of transportation research projects funds reflects the level of scientific and technological research and development investment in China's logistics industry; in terms of scientific and technological output, the value of logistics patent applications and the added value of logistics industry respectively indicate the stage of technological innovation. Knowledge output and economic output, logistics technology innovation is essentially to strengthen the efficiency of industry transportation organization, so the use of cargo turnover to reflect. The specific evaluation index system constructed is shown in Table 1.

The above indicator system satisfies the number of decision-making units at least three times the sum of the input-output indicators, and the basic data required for the research mainly comes from the China Statistical Yearbook (2015-2017) and the China Third Industry Statistical Yearbook (2015-2017) and 2014-2016 "Technology Statistics of Highway and Waterway Transportation", in which the basic data of logistics patents from 2014 to 2016 comes from the "patent industry patent information service platform". First of all, the platform is divided into six categories of industries such as loading and unloading, logistics, inventory (storage, storage) technology, circulation processing, sorting and packaging distribution system and logistics information technology according to the seven functional elements of the logistics industry. Secondly, relying on patents The “Second Search” function of the information service platform can search for the patents of invention patents, utility models and designs in different industries and sub-years, and can obtain the national logistics patent data of the six major industries from 2014 to 2016 respectively. Finally, with the help of the platform The “Analysis of the Distribution of National Provinces and Provinces” function can obtain the initial data of the number of patent applications in the logistics industry in 30 provinces in China (due to the serious lack of Tibet logistics patent data, which is not included in the scope of research).

Table 1. Input and output variables of scientific and technological innovation resource allocation in logistics industry

Index category	Index symbol and its name	unit
Science and technology innovation input index	X1: Total investment in transportation research projects	Year of the human
	X2: Financial expenditure for transportation	Billion
	X3: Fixed assets investment in transportation, warehousing and postal services	Billion
	X4: Actual expenditure of transportation research project funds this year	Billion
Scientific and technological innovation output index	Y1: Value added of the logistics industry	Ten thousand yuan
	Y2: The number of logistics patent applications	Piece
	Y3: Cargo turnover	100 million tons

4. Empirical Analysis

This paper establishes an output-oriented SMB model, and uses DEA-SOLVER Pro5.0 software to measure the efficiency of scientific and technological innovation resource allocation in logistics industry in 30 provinces of China, and can obtain its comprehensive efficiency value (TE) and pure technical efficiency value (PTE) and scale efficiency value (SE). The results are shown in Table 2.

4.1. Overall Situation of Resource Allocation Efficiency of Science and Technology Innovation in Logistics Industry

It can be seen from Table 2 that the average efficiency of the allocation of science and technology innovation resources in China's logistics industry from 2014 to 2016 is 0.591, which indicates that the overall level of resource allocation efficiency of science and technology innovation in China's logistics industry is not high, and the ability to transform input resources into scientific and technological innovation results is low. There are large differences between different provinces and cities and different provinces and cities in different years, which can be roughly divided into three categories: (1) Provinces with stable resource allocation efficiency. Seven provinces including Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu and Anhui have been in the optimal state of resource allocation for three consecutive years, and the pure technical efficiency value and scale efficiency value are all 1, including Beijing, Hebei, Shanghai and Jiangsu. Due to geographical advantages, the eastern provinces and cities have gathered a large number of innovative elements such as manpower, material resources and technology. The total output of the three types of science and technology accounted for 21.67%, 29.21% and 25.31% of the national total, respectively, and the added value and patent of the logistics industry in Jiangsu Province. The number of applications has always remained the first in the country. (2) Provinces with unstable resource allocation. The resource allocation efficiency of Inner Mongolia, Sichuan, Heilongjiang and Zhejiang provinces was only effective in one year. The resource allocation efficiency of Shandong and Henan provinces was the best in 2014-2015, while the resource allocation of Hunan, Guangdong and Ningxia provinces was the best. Efficiency has been optimized and adjusted to be effective in 2016, which is related to the implementation of the “supply-side structural reform”policy by the local government. (3) Provinces where resource allocation efficiency has not changed much year by year. Except for Fujian Province, the resource allocation efficiency of other provinces is below the national average, and most of them are concentrated in the central and western regions; the efficiency values of Hainan, Guizhou, Yunnan, Gansu, Qinghai and Xinjiang are all less than 0.22. In the lowest position, the side reflects that the state's policy support for these provinces is not in place, and it is difficult to effectively attract the accumulation of innovative resources, resulting in inefficient logistics resource creation.

The comprehensive efficiency level of resource allocation depends on pure technology efficiency and scale efficiency. Pure technology efficiency directly reflects the technical level of innovation resource utilization, and scale efficiency can reflect the internal management and operation level of the industry. It can be seen from Table 3 that the scale efficiency of the allocation of science and technology innovation resources in China's logistics industry in 2014-2016 is significantly higher than that of pure technology. The average value of pure technical efficiency increases first and then decreases, the highest is only 0.746, and the technology conversion capacity is low, resulting in the most effective use of human, financial, material, and technical input resources; and the average efficiency of scale is in the range of (0.86, 0.92). Compared with the optimal scale, it can be seen that the production cost and management cost of China's logistics industry are gradually becoming smaller. Therefore, pure technology inefficiency has become a key factor in lowering the level of scientific and technological innovation resource allocation in China's logistics industry. Secondly, the scale is not good, and it is necessary to optimize the operation scale of the industry and introduce hardware facilities reasonably.

Table 2. Efficiency Value of Science and Technology Innovation Resource Allocation in Logistics Industry of China from 2014 to 2016

	province	2014			2015			2016		
		TE	PTE	SE	TE	PTE	SE	TE	PTE	SE
Eastern china	beijing	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	tianjing	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	hebei	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	shanghai	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	jiangsu	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	zhejiang	1.000	1.000	1.000	0.843	1.000	0.843	0.826	1.000	0.826
	fujian	0.638	0.656	0.974	0.744	0.747	0.996	0.628	0.706	0.889
	shandong	1.000	1.000	1.000	1.000	1.000	1.000	0.754	1.000	0.754
	guangdong	0.878	1.000	0.878	0.830	1.000	0.830	1.000	1.000	1.000
	hainan	0.212	1.000	0.212	0.143	1.000	0.143	0.161	0.263	0.613
	average value	0.873	0.966	0.906	0.856	0.975	0.881	0.837	0.897	0.908
Central china	shanxi	0.520	0.671	0.775	0.540	1.000	0.540	0.392	0.415	0.945
	anhui	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	jiangxi	0.436	0.502	0.868	0.507	0.564	0.899	0.421	0.431	0.975
	henan	1.000	1.000	1.000	1.000	1.000	1.000	0.622	0.720	0.864
	hubei	0.465	0.469	0.993	0.410	0.473	0.869	0.403	0.501	0.803
	hunan	0.627	0.637	0.985	0.684	0.770	0.888	1.000	1.000	1.000
	average	0.675	0.713	0.937	0.690	0.801	0.866	0.640	0.678	0.931
Western China	neimenggu	0.235	0.257	0.914	1.000	1.000	1.000	0.151	0.151	0.999
	guangxi	0.483	0.497	0.971	0.586	0.609	0.963	0.489	0.507	0.965
	chongqing	0.422	0.445	0.947	0.551	0.595	0.925	0.415	0.419	0.992
	sichuan	0.396	0.473	0.838	1.000	1.000	1.000	0.214	0.331	0.645
	guizhou	0.145	0.156	0.927	0.169	0.174	0.968	0.164	0.184	0.892
	yunnan	0.117	0.123	0.948	0.132	0.142	0.925	0.103	0.135	0.769
	shanxi	0.485	0.498	0.973	0.363	0.375	0.970	0.354	0.387	0.915
	gansu	0.191	0.212	0.901	0.213	0.239	0.890	0.182	0.183	0.996
	qinghai	0.035	0.051	0.698	0.072	0.111	0.656	0.056	0.065	0.868
	ningxia	0.297	1.000	0.297	0.267	1.000	0.267	1.000	1.000	1.000
	xinjiang	0.183	0.209	0.876	0.170	0.223	0.761	0.181	0.184	0.983
	average	0.272	0.357	0.845	0.411	0.497	0.848	0.301	0.322	0.911
Northeast China	liaoning	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	jilin	0.223	0.243	0.916	0.283	0.376	0.752	0.253	0.281	0.902
	heilongjiangan	1.000	1.000	1.000	0.738	1.000	0.738	0.393	0.394	0.998
	average	0.741	0.748	0.972	0.674	0.792	0.830	0.549	0.558	0.966
National average		0.599	0.669	0.896	0.641	0.746	0.860	0.572	0.608	0.919

4.2. Analysis of Regional Status of Resource Allocation Efficiency in Logistics Technology Innovation

In March 2015, Premier Li Keqiang pointed out that it is necessary to expand the new space for regional development and coordinate the implementation of the strategic combination of the “four major plates” and the “three major support belts”. The “four major plates” are the four regions of the eastern, central, western and northeastern regions. To this end, the radar map shows the changes in the resource allocation efficiency of China's four major regions in 2014-2016, and the differences in the allocation of logistics technology innovation resources in different regions can be compared, as shown in Figure 1.

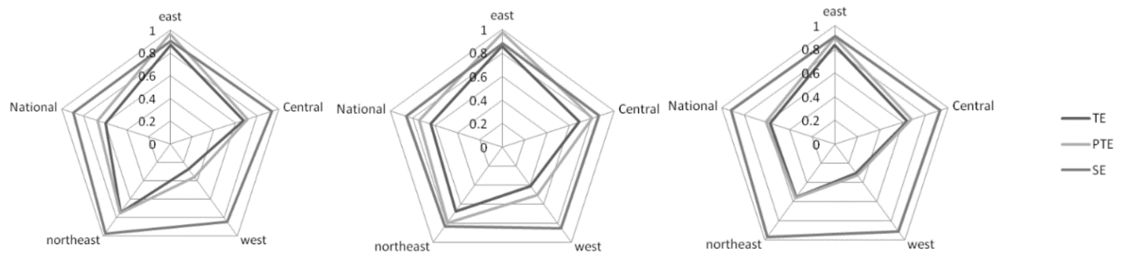

Figure 1. Changes in annual average resource allocation efficiency of China's logistics industry in 2014-2016

From the above figure, we can see that the regional characteristics of China's logistics industry's scientific and technological innovation resource allocation efficiency are obvious, showing the trend of decreasing from east to west. The average efficiency of the eastern region is 0.855, which is much higher than the national average. The second and northeast regions are 0.668 and 0.654 respectively, slightly higher than the national average, while the western region has the lowest performance of 0.301, far below the national average. Depending on the location, the eastern region itself has developed economy and complete logistics technology infrastructure, which has created a good environment for scientific and technological innovation for the development of the logistics industry, and can effectively bring together innovative resources such as people, finance, materials and technology. Taking 2016 as an example, the total amount of four science and technology inputs in the eastern region accounted for 55.54%, 41.00%, 37.81% and 77.26% of the national total, respectively. The total output of the three major technologies accounted for 50.82%, 65.16% and 53.99 of the national total, respectively. %, which is a typical high-input and high-output area, has become a leader in China's technological innovation. With the promotion of the "Belt and Road" construction, the central region has become an increasingly prominent transportation hub in the eastern, central and northeastern regions. With its unique location advantages, it has attracted a large amount of investment and advanced technology for the construction of logistics technology innovation platform, resulting in the central region becoming the second largest area of technological innovation. The efficiency level in the Northeast is second only to the central region, but it is much higher than that in the western region. The reason is that the northeast revitalization strategy has continued to advance, which has promoted in-depth exchanges and cooperation between the Northeast and other regions, and can learn in the process of improving the logistics technology innovation capability. Advanced management experience and innovative models. However, the natural environment and geographical conditions in the western region are not good, and there is no good policy environment. As a result, the scientific and technological innovation capability of western logistics is weak, and the 11 provinces in the west have not achieved DEA effectiveness. Taking 2016 data as an example, the total investment in logistics technology in the central region accounts for 16.02% of the country, and the total output of science and technology accounts for 19.94% of the country. The total investment in science and technology in Northeast China accounts for only 4.26% of the country, but it has achieved 6.69% of the country's technology. The total output, typically less investment in less output areas; while the western region accounts for 26.82% of the country's science and technology input resources, but the total output of science and technology only accounts for 16.71% of the country; indirectly indicates that the regional distribution of China's science and technology innovation resources is extremely unreasonable There are still a lot of invested resources that are not fully utilized.

In addition, the scale efficiency values of each region in 2014-2016 are closer to the outermost layer of the radar chart, while the pure technical efficiency is at the innermost level, indicating that the main reason for the low level of logistics technology innovation resource allocation in China is purely technically inefficient, in line with the previous Explain the conclusions.

4.3. Relaxation Analysis of the Efficiency of Innovation Resource Allocation in Ineffective Provinces

The inefficiency of the allocation of scientific and technological innovation resources is due to both the excess investment and the insufficient output, which has become the primary problem that restricts the sustainable development of China's logistics industry. It is necessary to further analyze the slack situation of the allocation of scientific and technological innovation resources in the ineffective provinces from 2014 to 2016, reveal the advantages and shortcomings of the provinces in the process of scientific and technological innovation, and then improve the input and output. The analysis results are shown in Table 3.

(1) From a national perspective, the redundancy rate of project workload input is the highest, at 38.00%, indicating that the proportion of logistics talents in each region is significantly out of balance with its geographical area. Some provinces and cities have problems in blindly introducing researchers, leading to research and development. The duplication and inefficiency of the work; and the investment redundancy rate of the project capital expenditure is only 0.78%, which basically realizes the effective allocation of technical input and can effectively master the research and development of core technologies. In terms of output, the number of patent applications and cargo turnover showed serious output shortages, which were 341.44% and 242.96% respectively. It is urgent to optimize the input structure of each innovative resource and continuously improve the R&D and innovation output of the logistics industry.

(2) There are advantages and disadvantages in the allocation of innovative resources in various regions. The redundancy ratios of project investment, fiscal expenditure and project capital expenditure in the eastern provinces and municipalities are 27.45%, 6.79% and 0.76%, respectively. The ability to integrate human, financial and technical resources is strong, but the number of patent applications still needs to be improved. The utilization rate of fiscal expenditure and fixed asset investment in the central provinces and municipalities is relatively high, but the redundancy rate of manpower and technology input is much higher than the national average, resulting in serious waste of manpower and technology investment, which restricts the development of science and technology innovation in logistics in the central region. Both the western and northeastern provinces and cities can effectively use project capital expenditures. However, there are serious shortages of the three logistics technology outputs in the western provinces and municipalities. It is urgent to introduce relevant science and technology innovation policies, optimize the quality and efficiency of innovation resources supply, and improve the ability of innovation output; the insufficiency rate of the added value of the logistics industry in Northeast China is only 1.96%, which can give full play to the economic effects of technological innovation.

Table 3. Analysis of input and output slack in provinces with low efficiency in resource allocation of scientific and technological innovation

province	Input redundancy rate				Output deficiency rate		
	X1	X2	X3	X4	Y1	Y2	Y3
shanxi	50.77%	1.33%	4.38%	0.00%	1.99%	251.85%	79.18%
neimenggu	27.02%	0.00%	3.53%	0.00%	0.00%	653.73%	56.30%
jilin	60.21%	0.00%	12.23%	0.00%	3.91%	537.94%	355.06%
heilongjiang	21.52%	17.40%	6.30%	0.00%	0.00%	56.76%	132.97%
zhejiang	31.16%	0.00%	3.97%	0.00%	0.00%	0.00%	39.63%
fujian	35.55%	0.00%	35.48%	0.00%	0.37%	41.92%	108.05%
jiangxi	85.50%	17.99%	4.84%	0.00%	22.83%	234.06%	107.55%
shandong	5.27%	0.00%	9.62%	3.80%	0.00%	0.00%	32.71%
henan	20.96%	0.00%	4.80%	0.00%	0.00%	15.84%	44.92%
hubei	60.47%	0.00%	17.15%	14.23%	102.31%	77.12%	227.40%
hunan	30.48%	0.59%	8.86%	0.00%	0.00%	40.12%	65.46%
guangdong	46.30%	28.81%	0.00%	0.00%	0.00%	7.83%	26.55%
guangxi	79.23%	0.00%	39.93%	0.00%	39.19%	143.98%	99.05%
hainan	18.97%	5.16%	0.81%	0.00%	54.60%	999.90%	97.42%
chongqing	0.00%	0.00%	2.08%	0.00%	75.50%	64.24%	219.79%
sichuan	15.31%	0.28%	21.99%	0.00%	58.92%	56.02%	405.75%
guizhou	54.12%	2.98%	15.65%	0.00%	30.94%	643.77%	889.17%
yunnan	22.61%	15.03%	0.00%	0.00%	406.32%	813.61%	959.12%
shanxi	41.24%	7.90%	13.64%	0.00%	80.77%	106.81%	276.16%
gansu	67.83%	12.78%	8.63%	0.00%	214.35%	754.87%	271.18%
qinghai	73.43%	33.03%	0.00%	0.00%	627.66%	999.90%	637.59%
ningxia	14.22%	16.96%	0.00%	0.00%	1.78%	439.97%	70.41%
xinjiang	11.78%	7.17%	1.97%	0.00%	38.96%	912.77%	386.66%
east	27.45%	6.79%	9.98%	0.76%	10.99%	209.93%	60.87%
central	49.63%	3.98%	8.01%	2.85%	25.43%	123.80%	104.90%
west	36.98%	8.74%	9.77%	0.00%	143.13%	508.15%	388.29%
northeast	40.86%	8.70%	9.27%	0.00%	1.96%	297.35%	244.01%
national	38.00%	7.28%	9.39%	0.78%	76.54%	341.44%	242.96%

(3) The degree of utilization of innovative resources in different provinces and cities is not the same. Zhejiang Province not only realized the optimal allocation of fiscal expenditures and project funds, but also realized the output value of the logistics industry and the output of patent applications, and the biggest drawback was the relatively excessive investment in project workload. In addition to the high redundancy of investment in fixed assets investment, Chongqing has the most effective use of resources such as human resources, financial resources

and technology. The shortcoming is that the output efficiency of logistics industry added value and cargo turnover is low. The material and technical inputs of Yunnan and Qinghai provinces were fully utilized, but the three scientific and technological outputs were seriously insufficient. Therefore, if each invalid province wants to achieve DEA effectiveness, it needs to make effective adjustments in terms of input and output. In Xinjiang, for example, there are three problems of excessive investment in science and technology and insufficient output of three technologies. The workload, fiscal expenditure and fixed assets investment decreased by 11.78%, 7.17% and 1.97% respectively. On the output side, the added value of the logistics industry needs to increase by 38.96%, the patent application volume needs to increase by 912.77% and the cargo turnover needs to increase by 386.66%.

5. Conclusion

This paper uses the output-oriented SBM model to measure the efficiency of science and technology innovation resource allocation in the logistics industry of 30 provinces in China from 2014 to 2016, and uses the panel Tobit model to influence the key factors affecting efficiency from three aspects: overall status, technical level and management system. Conduct an empirical discussion and get the following conclusions:

(1) During the period of 2014-2016, the average efficiency of resource allocation efficiency of science and technology innovation in China's logistics industry was 0.604, and the overall efficiency of resource allocation was low. There were significant differences between different provinces and different provinces in different provinces. The main reason for the low level of scientific and technological innovation resource allocation in the logistics industry is pure technology inefficiency, that is, the level of resource utilization technology is lagging behind, and secondly, the scale efficiency is not good, that is, the internal operation and management mode is unreasonable; therefore, it is necessary to pay attention to “software” and so on. Technology-based, "hardware" and other equipment and facilities supplemented, improve the level of scientific and technological innovation resources allocation.

(2) The regional gradient characteristics of China's logistics industry's science and technology innovation resource allocation efficiency during 2014-2016 are obvious, showing the trend of “east-central-north-west-west” step by step. The average resource allocation efficiency in the eastern region is 0.855, followed by the middle and the northeast region is 0.668 and 0.654 respectively, and the west is 0.301. The reason for the large gap between the regions is inextricably linked with the local policy environment and economic environment. Due to the favorable economic development conditions and geographical location, the efficiency of innovation resource allocation in the eastern region is always at home. At the leading level, the efficiency of resource allocation in the central region is slightly higher than that in the northeast region, while the economic development in the western region itself is backward. In addition to the harsh natural conditions, the resources invested by innovation are not fully utilized, resulting in the long-term survival of most provinces.

(3) According to the slack in input and output, in general, the input workload of the project workload is too high, the project funds can be effectively used, and the patent application volume and cargo turnover are both severely insufficient in output; The allocation of innovative resources varies from province to city. For example, in the western region, 11 provinces have not achieved DEA effectiveness. In terms of human, financial and material resources, in addition to Chongqing, Yunnan, and Qinghai, other provinces have invested in innovative resources. The balance is serious, and the three science and technology output shortage rates are high.

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References

[1] Cai Jin. Multi-measures to promote logistics technology innovation [J].Logistics Technology and Application,2014,19(11):48-49.

[2] Deng Hengjin. The logical structure and application ideas of regional logistics innovation system [J]. Business Research, 2012 (03): 188-194.

[3] Yu Wenqiang. Research on Transformation and Upgrading of Logistics Enterprises with Innovation Efficiency-oriented [J]. Logistics Engineering and Management, 2016, 38(07): 5-7.

[4] Li Shoulin, Zhao Rui, Chen Lihua. Analysis of Innovation Efficiency of Logistics Listed Enterprises Based on DEA [J].Western Economic Management Forum, 2018,29(04):55-62.

[5] Sarminah Samad. The Influence of Innovation and Transformational Leadership on Organizational Performance [J]. Procedia - Social and Behavioral Sciences, 2012, 57.

[6] Peter V. Hall, Thomas O'Brien, Clarence Woudsma. Environmental innovation and the role of stakeholder collaboration in West Coast port gateways [J]. Research in Transportation Economics, 2013, 42 (1).

[7] Marcella De Martino,Luisa Errichiello,Alessandra Marasco. Logistics innovation in Seaports: An inter-organizational perspective[J]. Research in Transportation Business & Management, 2013, 8.

[8] Wai Peng Wong, Keng Lin Soh, Mark Goh. Innovation and productivity: insights from Malaysia's logistics industry [J]. International Journal of Logistics Research and Applications, 2016, 19 (4).

[9] Wei Quanling. Data Envelopment Analysis (DEA) [J]. Science Bulletin, 2000 (17): 1793-1808.

[10] Wu Fuxiang. Application of Parameter and Nonparametric Frontier Methods in Productivity Efficiency Measurement [J]. Journal of Mathematical Statistics and Management, 2005(05): 50-55.

[11] Kaoru tone. Variations on the theme of slacks-based measure of efficiency in DEA [J]. European Journal of Operational Research, 2009, 200 (3).

[12] Kaoru Tone. A slacks-based measure of efficiency in data envelopment analysis [J]. European Journal of Operational Research, 2001, 130 (3).

[13] Ning Zhang,Yongrok Choi. Environmental energy efficiency of China's regional economies: A non-oriented slacks-based measure analysis [J]. The Social Science Journal, 2013, 50(2).

[14] You Daming, Yan Yating, Jiang Wei. An Empirical Study on the Efficiency of Regional Science and Technology Innovation Resource Allocation in China——Based on Output-Oriented SBM Model and Malmquist Productivity Index[J].Soft Science, 2017, 31(08): 71-75 +85.

[15] Wang Yuhong, Liu Qi.Study on Logistics Efficiency Measurement of the Yangtze River Economic Belt Based on Super-SBM Model[J].East China Economic Management,2017,31(05):72-77.