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Evaluation of Economic Efficiency in Western Regions from a New Perspective ——Empirical Research Based on the Three-stage DEA Model

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Abstract: *This paper uses the three-stage DEA analysis method proposed by Fried et al. (2002) to correct the influence of factors such as environmental variables and random disturbances, and conducts an empirical analysis on the economic efficiency of 31 provincial-level regions in my country from 2010 to 2016. By comparing the economic efficiency of the western region with the central and eastern regions, it focuses on the economic development efficiency of the western region under the new perspective. The study found that the overall level of economic efficiency in China is relatively low, the economic efficiency of the eastern part remains leading and stable, and the efficiency of the central and western regions is relatively low and fluctuates greatly. The overall efficiency of the provincial economy in the western region is relatively low, and the overall efficiency of my country's economic development is gradually converging. We should focus on the characteristics of current economic development and increase investment in the economic development of the western region while maintaining stable economic growth in the eastern and central regions, so as to solve the problem of unbalanced regional economic development in our country.*

Keywords: *Three-stage DEA; Western region; Input-output; Economic efficiency*

1. Research background

The western development strategy implemented by our country is a comprehensive systematic project, which includes a wide range of content. After more than 10 years of development and construction in the western region, remarkable achievements have been made in various undertakings in economic development, social progress, ethnic unity, and border stability in the western region. In the process of developing the western region, where is the main driving force for the development of the western region? In what way is the transmission of economic energy realized? Does the unbalanced development model in the western region have any impact on the overall economic development? Questions such as what role and influence it has on the development of the western economy are urgently needed to be resolved and clarified, and in-depth research and discussion are needed.

Since the implementation of the western development strategy for ten years, thanks to the support of national policies, funds and technologies and the joint efforts of all ethnic groups in the western region, the western economy has achieved rapid development in all aspects, the infrastructure has been continuously improved, and scientific and technological achievements have been made. Great progress has been made, and the quality of the population has also been greatly improved. The average annual growth rate of GDP in the western region is 11.9%, which is higher than the national growth rate over the same period. From 2000 to 2009, the GDP of the western region increased from 1.66 trillion yuan to 6.68 trillion yuan, an increase of three times, and its proportion in the country increased from 17.1% to 18.5%. No matter what metrics are used to measure, the western region's economy is growing at such a high rate that it is very eye-catching. With the implementation of the "One Belt, One Road" strategy, the economic situation in the western region has become more diversified. On the basis of the development of the western region, it will continue to develop and balance the economic differences between the eastern, central and western regions. Therefore, it is particularly necessary to study which factors have affected the economic development and the degree of influence in the evaluation of the economic development efficiency of the western region.

Under the “One Belt, One Road” strategy construction, the western region relies on its natural resources and the support of national policies, and the economic growth rate is advancing by leaps and bounds. While industries are moving to the west, the environmental pressure in the west has also

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increased. How to efficiently develop environmentally friendly economy is something we need to think about.

2. Literature review

2.1. Research on efficiency evaluation methods at home and abroad

Around the problem of efficiency, the research carried out by domestic and foreign scholars mainly includes the free distribution method DFA (Distribute Free Approach), the stochastic frontier method SFA (Stochastic Frontier Approach), the thick frontier analysis method TFA (Thick Frontier Approach), and the unbounded analysis method FDH (Free Disposal Approach). Analysis), data envelopment analysis method DEA (Data Envelopment Analysis) and other directions.

DFA (Distribute Free Approach) is an analysis method proposed by Berger (1993) based on the early panel data theory. By separating the X inefficiency term and the random error term, each individual's inefficiency value is compared to the best unit in the sample, resulting in a relative efficiency value for each individual in a given sample. Stochastic Frontier Approach SFA (Stochastic Frontier Approach) is a method for estimating efficiency by using stochastic frontier production function. The method was independently proposed by Aigner, Lovell & Schmidt (1977) [1], and Meeusen & van den Broeck (1977) [2], and is a parametric method. The SFA model estimates the technical efficiency of the decision-making unit by decomposing the error term. The error term is divided into two parts, one representing random error and the other representing technical inefficiency. The thick frontier method (TFA) also defines the functional form of the efficiency frontier, but it uses regression analysis to estimate the parameters of the production function and obtains an average production function that passes through the "center" of the observation points of all samples (Berger and Humphrey, 1991). TFA assumes that the calculated efficiency value deviates from the expected efficiency value, reducing the influence of extreme points in the sample data on the calculated efficiency value, which is consistent with the DEA method, except that the DEA method eliminates the Extreme point. The unbounded analysis method FDH is a special case of the DEA model, and the points on the line connecting the vertices of the DEA front are not identified as the efficiency front. Since the FDH front coincides with the DEA front or is located inside the DEA front, the average efficiency values calculated by the FDH method are usually higher than those calculated by the DEA method.

Among the above methods, DEA (Data Envelope Analysis) is the most commonly used method. The DEA method has outstanding advantages: DEA does not need to know the specific form of the production function, and can handle multi-input and multi-output situations freely: DEA uses the optimization method to endogenously determine the weights of various input factors, excluding many subjective factors, with It has the advantages of having nothing to do with market prices, and is especially suitable for the efficiency evaluation of complex economies such as cities and regions. At present, Chinese scholars have used the DEA method to measure regional and urban economic efficiency related research: Yang Kaizhong [3] and others used the DEA method to evaluate the input-output efficiency of my country's municipalities and provincial capitals, and believed that the input-output efficiency of the western region was far lower. In the eastern region; Yan Pengfei and others used the DEA method to measure the research and found that China's total factor productivity is increasing, mainly due to the improvement of technical efficiency; Feng Zhenhuan et al. used DEA to evaluate the classification effectiveness of China's regional investment, drawing a On this basis, some scholars use the super-efficiency DEA model to measure the economic efficiency of my country's cities, such as: Yuan Xiaoling and others used the super-efficiency DEA model to evaluate the 15 The evolution characteristics of the efficiency of sub-provincial cities; Song Malin et al. used the super-efficiency DEA model to analyze and evaluate the current situation of the competitiveness of cities along the river in Anhui. The model has more advantages in application. However, there are few related studies using the super-efficiency DEA model at present, and even less measure the regional economic development efficiency of each province in my country and analyze its temporal and spatial changes.

2.2. Domestic and foreign studies on the economic efficiency of the western region

Focusing on the issue of economic efficiency in the western region, Liu Cai and Jiang Nan analyzed the rise of the northwest and concluded that the GDP of the western region will continue to rise only if the infrastructure is solidly constructed [4]. The research group of "Research on the Sustainable Economic Growth Power of Western Regions under the New Normal" showed through research that

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innovation-driven and structural transformation have become the strong driving forces for the sustainable economic development of the Western Regions. (Divided into categories)

Chang Jianxin and Yao Huiqin used the SBM model of undesired output to calculate and found that the environmental-economic efficiency value after considering environmental pollution variables has a significant decline compared with the economic efficiency value. The accuracy and credibility of the environmental-economic efficiency evaluation higher degree. Cao Zijian, Su Xinhua used the dynamic DEA model to evaluate the comprehensive development efficiency of circular economy in western provinces, autonomous regions and municipalities, pointed out the redundant input and insufficient output in the development of circular economy in non-DEA effective areas, and finally proposed ways to improve the development efficiency of circular economy. reform path.

Liu Yi, Wang Xueya used factor analysis, Sun Jingshui, Kong Weifei constructed a comprehensive evaluation system and other methods in establishing the index weights are too subjective, it is difficult to exclude the error of human factors. In contrast, the data envelopment analysis method (DEA method) is more objective to evaluate through data and scientific data models. Therefore, many scholars mentioned above chose to use the DEA method to evaluate the development efficiency of China's regional economy. analysis.

However, when solving problems, the traditional one-stage DEA has obvious defects. The influence relationship of environmental variables on efficiency is usually not known before the research. If the classification of environmental variables is wrong, the obtained efficiency value will be biased. error. In essence, the two-stage DEA study cannot separate the influence of environmental and error factors on the efficiency value, so the results of the two-stage DEA are also biased. To this end, fried et al. (2002) proposed a new efficiency evaluation model - DEA three-stage method. The biggest feature of this method is that it can remove the influence of the external environment and random errors on the efficiency, so that the calculated efficiency value can more truly reflect the actual situation.

We agree with Huang Sen and Pu Yongjian using the DEA three-stage method to analyze the regional economy, and agree with Xu Min and Jiang Yong's evaluation of economic efficiency in Xinjiang, a representative western region. The above literatures provide reference and help to the research on regional economic efficiency evaluation, but there are also the following shortcomings: First, there is a lack of in-depth research on the western regional economy. At present, most of the research on the western regional economy stays on the macro analysis, and there is a lack of in-depth research on each region in the regional economic belt like Xu Min and Jiang Yong. Second, the DEA method is less used in the western regional economy. At this stage, DEA method is mainly used in the analysis of commercial banks and scientific and technological input-output problems. The scientific DEA model can be used to evaluate the efficiency of regional economic development more effectively.

Therefore, this paper constructs scientific and reasonable input-output indicators, and uses the DEA three-stage method to conduct an empirical analysis on the economic efficiency of 31 provincial-level regions in my country from 2010 to 2016. By comparing the economic efficiency of the western region with that of the central and eastern regions, this paper conducts an in-depth study of the economic development efficiency of the western region from a new perspective.

3. Indicator description

3.1. Selection of input and output indicators

According to the neoclassical growth theory in economics that output growth is mainly promoted by capital factors, labor factors and technological progress, this paper selects input and output indicators. The selection of input and output indicators is very sensitive to the impact of DEA model efficiency analysis. Using the DEA method to study economic efficiency, first select indicators based on the characteristics of my country's economic development and the availability of data, and to meet the DEA method indicator selection principle: the maximum number of indicators does not exceed half of the sample size or the number of input-output indicators. The product is not greater than the number of samples.

Since the data envelopment method calculates the relative efficiency, as long as the relative consistency of the data is ensured, the accuracy of the evaluation results can be guaranteed. Therefore, this paper selects the local fiscal expenditure X1 and fixed asset investment X2 of each province to reflect the input of capital elements. When choosing the labor force index, this paper selects the number of

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private enterprises and self-employed persons X3 by industry in each province to reflect labor factor input. When selecting the technical input index, this paper chooses the scientific research funding input (thousand yuan) X4 to reflect the input of technological progress.

In the selection of output indicators, on the one hand, the growth of the overall economy should be considered, and on the other hand, the improvement of residents' living standards should be considered. Therefore, this paper uses GDP (100 million yuan) Y1 and local fiscal revenue (100 million yuan) Y2 to reflect the provinces. economic growth. Considering the various measures of social welfare level, this paper chooses the total retail sales of consumer goods (100 million yuan) Y3 to reflect the people's material and cultural living standards, and then reflects the consumption capacity of residents in each province, and evaluates the material welfare level of residents in each province from the side.

The selection of the above indicators in this paper mainly highlights the ecological and environmental factors in the economic efficiency evaluation of each province, which has a certain ecological and environmental protection significance for the comparative analysis of the economic efficiency of each province. In this paper, my country is divided into three major regions, east, middle and west for comparative analysis. The western region chooses 12 provinces and municipalities including Sichuan, Chongqing, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Tibet, Ningxia, Xinjiang, Guangxi and Inner Mongolia, and the eastern region chooses Beijing., Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan 11 provinces and municipalities, and the remaining provinces and cities are the central region.

3.2. Selection of environment variables

Environmental variables refer to factors that affect the economic efficiency of each province but are not within the subjective controllability of each province. Its selection has a crucial impact on the analysis results of the three-stage DEA. Combined with the actual situation of my country's economy and the factors affecting economic efficiency, this paper selects the total import and export of goods by region E1, teaching and research personnel E2, and hospital bed utilization E3 as environmental variables.

The degree of openness to the outside world is embodied in the degree of openness of the local market, which reflects all aspects of the local foreign trade. On the one hand, the degree of opening to the outside world shows the ability of a region to conduct foreign economic transactions, and on the other hand, it reflects the level of the region's construction of inter-regional transportation infrastructure. At present, the degree of opening to the outside world in each region is mainly reflected by the import and export of products. Therefore, this paper uses the total import and export of goods by region to measure the degree of local foreign economic opening (the import and export volume is converted into USD/RMB according to the exchange rate of the year).

The higher the quality of production factors, the higher the overall economic productivity, which can promote the efficiency of economic development. But the quality of production factors is difficult to control, especially the investment in the quality of scientific research personnel. Therefore, this paper chooses teaching and research personnel to reflect the development of education as an indicator.

The utilization rate of hospital beds is the ratio of daily use of beds to actual beds. It reflects the general load of hospital beds and the utilization efficiency of hospital beds. It is the main indicator of hospital efficiency. According to the principle of public needs, it should be determined by meeting the public needs of residents, such as the most basic needs for survival, production and living, which are embodied in basic living security, old-age security, medical security, etc. Therefore, this paper chooses the utilization rate of hospital beds to reflect residents' medical care. Construction security.

4. Empirical Research

Use the regression results of the second-stage SFA model to adjust the original input value. Substitute the adjusted input value and the original output value into the DEAP2.1 software to obtain the comprehensive input efficiency, pure technical efficiency and scale efficiency of the third stage.

4.1. Static analysis of economic efficiency after adjusting investment

4.1.1. Static analysis of the original input efficiency evaluation of 31 provinces across the country

Table 8 shows that after removing the influence of external environmental variables and random

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factors on the original input efficiency, from the overall point of view, the average values of the original input technical efficiency, pure technical efficiency and scale efficiency of 31 provinces and cities from 2010 to 2016 were 0.772, 0.928 and 0.831. Comparing the efficiency measurement results of the first and third stages, it can be seen that the national average comprehensive efficiency in 2010-2016 dropped from 0.833 before adjustment to 0.772, the average scale efficiency dropped from 0.994 to 0.831, and the pure technology The efficiency increased from 0.882 to 0.928. The average scale efficiency is smaller than the pure technical efficiency, and the gap increases, indicating that its main constraint is the low scale efficiency, and the scale of its own development should be increased according to the actual local conditions. In the third stage, the national average comprehensive efficiency level is 0.772, which is still far from the efficiency frontier, indicating that there is actually a lot of room for improvement in the original input efficiency.

According to different provinces and cities, in the third stage of DEA, among the 31 provinces in the country, the average comprehensive efficiency decreased, and 15, 5 and 11 remained unchanged and increased respectively; the pure technical efficiency decreased and remained unchanged. There are 6, 6 and 19 provinces that have increased and increased; the scale efficiency has decreased, and 23, 4 and 4 provinces have remained unchanged and increased respectively; Tianjin, Shanghai, Shandong and Guangdong are at the frontier of efficiency The four provinces are consistent before and after the adjustment, indicating that the original input efficiency of the four provinces of Tianjin, Shanghai, Shandong and Guangdong is indeed better. After adjustment, Qinghai Province and Tibet Province have the largest declines. The average efficiency of Qinghai dropped from 0.828 to 0.283, and the average efficiency of Tibet dropped from 0.678 to 0.12.

Similarly, according to the basis for the division of China's economic zones, China is divided into three regions: east, middle, and west, and the comprehensive efficiency values measured in Table 7 are calculated in three regions according to different years. In this way, the distribution of technical efficiency in different economic zones in China can be clearly displayed.

According to Figure 2, in the third stage, the average technical efficiency of each region and each year decreased after adjustment.

The average combined efficiency of the eastern, central and western regions is between 0.9-0.95, 0.75-0.85 and 0.55-0.7. The changes in the eastern region remained stable, the central region rose steadily, and the western region fluctuated to a greater extent, indicating that the main reason for the large fluctuations in the central region in the first stage was the influence of external environmental variables and random factors.

In the first stage of DEA, the average technical efficiency of the eastern region is higher than that of the other two regions, which is consistent with the third stage of DEA, and is in line with the specific situation that the comprehensive index of the eastern region is higher than the other two regions. However, according to the comparison between Figure 1 and Figure 2, it can be seen that the comparison between the two regions in the central and western regions is inconsistent, indicating that there are certain defects in the first stage of DEA calculation.

Also taking 2013 as an example to analyze the state of scale, after excluding environmental factors, the number of provinces in the stage of diminishing returns to scale has dropped from 3 to 0, indicating that the efficiency of returns to scale is affected by environmental factors, and the province's economy can be improved simply by expanding the scale. Development efficiency is not feasible, and more attention should be paid to the impact of environmental factors in order to improve the quality of economic scale expansion. Except for the seven provinces of Beijing, Jilin, Shanghai, Jiangsu, Shandong, Guangdong and Guangxi, which are in constant returns to scale, all other provinces are in the stage of increasing returns to scale. The number of provinces in the stage of increasing returns to scale has increased from 14 to 24, indicating that industrialization and large-scale expansion are still the most critical areas for the improvement of economic and technological efficiency in each province, and appropriate scale expansion should be carried out. In contrast, Liaoning and Henan, which were both in the stage of diminishing returns to scale before and after the adjustment, ranked 6th and 7th in terms of their GDP. The two provinces of Liaoning and Henan should not unrestrictedly increase economic efficiency by expanding their scale, which will lead to unreasonable use and even waste of high-quality resources. Therefore, resources should be reasonably classified, quantitative and targeted investment should be made, and the results of reasonable allocation should be achieved.

4.1.2. Static analysis of the original input efficiency evaluation of 12 provinces in the western region

From the perspective of the western region, the average comprehensive efficiency of the western

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region is 0.771, the average pure technical efficiency is 0.928, and the scale efficiency is 0.831; the average comprehensive efficiency is 0.024 higher than the first stage, an increase of 3.22%, and the pure technical efficiency The average value is 0.094 higher than the first stage, an improvement of 11.25%, and the scale efficiency value is 0.073 lower than that of the first stage, a decrease of 8.12%. Obviously, the influence of external factors such as social environment leads to the underestimation of the traditional efficiency level and the overestimation of the degree of intra-regional differences by traditional DEA methods. There is a big gap between the two efficiency values of Qinghai and Tibet. The adjusted DEA analysis results of the third stage show that the number of provinces with a comprehensive efficiency value of 1 is 0; the number of provinces with a pure technical efficiency value of 1 is reduced to 1, which is Ningxia Province. The low pure technical efficiency is the main reason for the low technical efficiency of the western region in the first stage, and the large reduction of the scale efficiency is the main reason for the low technical efficiency in the third stage.

As far as the west itself is concerned, Inner Mongolia is still the province with the highest average comprehensive efficiency in the western region, but the average comprehensive efficiency value of Tibet and Qinghai in the third stage is quite different from that in the first stage.

It shows that the results of the first stage cannot truly reflect the actual situation, and there are falsely high values under the influence of external environmental variables and random factors. Therefore, these provinces can focus on two aspects. First, they should follow the path of connotative development, appropriately expand the scale, reasonably classify resources, and invest quantitatively and accurately to achieve the result of reasonable allocation. Second, strengthen the technical management level and improve the pure technical efficiency.

4.2. Dynamic analysis of economic efficiency after adjusting investment

According to the efficiency values measured in the third stage of DEA (as shown in Table 9), the economic efficiency is divided into four types as shown in Figure 3: "double high type", "high low type", "low high type" and "double low type" type. The first type is "double-high type", which refers to provinces whose pure technical efficiency and scale efficiency are higher than the national average, including Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Guangdong, Shandong, Henan, Hubei and Hunan 11 provinces and cities; the second type is "high and low", which means that the pure technical efficiency is higher than the national average, while the scale efficiency is lower than the national average, including Heilongjiang, Hainan, Fujian, Tibet, Qinghai, Ningxia, Xinjiang and There are 8 provinces and cities in Inner Mongolia. These 8 provinces and cities should take the road of connotative development, classify resources reasonably, invest quantitatively and accurately, and achieve the result of reasonable allocation; the third type is "low-high type", which means pure the technical efficiency is lower than the national average, while the scale efficiency is higher than the national average, including Liaoning Province and Sichuan Province. These provinces and cities focus on improving pure technical efficiency, lowering the threshold of capital entry, increasing institutional flexibility, and improving their own management level; fourth This type is "double low type", which means that both pure technical efficiency and scale efficiency are lower than the national average, including 10 provinces and cities including Jilin, Shanxi, Anhui, Jiangxi, Chongqing, Guizhou, Yunnan, Shanxi, Gansu and Guangxi. Pure technical efficiency and scale efficiency are both low. On the one hand, it is necessary to appropriately expand the scale and reasonably classify resources to achieve precise investment and achieve the results of reasonable allocation. On the other hand, strengthen the technical management level and improve the pure technical efficiency.

References

[1] Aiger D.J., Lovell C. A. K., and Schmidt P., 1977, Formulation and Estimation of Stochastic Frontiers Production Function Models [J], Journal of Econometrics, (6), 21-37
[2] Meeusenm W., and J. van den Broeck, 1977, Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error [J], International Economic Reviews, 2(18), 435-444
[3] Qiang C, Ye L. The evaluation of transportation energy efficiency: An application of three-stage virtual frontier DEA [J]. Transportation Research Part D: Transport and Environment, 2014, 29(jun.): 1-11.
[4] Shang J K, Hung W T, Lo C F, et al. Ecommerce and hotel performance: three-stage DEA analysis [J]. Service Industries Journal, 2008, 28(4): 529-540.