Usage Efficiency of Financial Poverty Alleviation Funds: An Empirical Analysis of China's Eastern Rural Areas

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Objective: The focus in this study is on how to improve the disharmony between the financial poverty alleviation investment model and the economic development efficiency.Methods:In this paper, based on the efficiency measurement principle of DEA method, an input-output model for evaluating the performance of poverty alleviation funds in counties of Shandong Province is constructed. Then, the data published by the government of 30 poverty-stricken counties in Shandong Province are selected and usedto measure the performance of poverty alleviation funds by Frontier Analyst 4.0 software according to indicators, including comprehensive efficiency analysis (CCR model), pure technical efficiency analysis (BCC model) and scale efficiency analysis (SE model).Results : (1) The average comprehensive efficiency of the use of financial poverty alleviation funds in 30 poverty-stricken counties in Shandong Province is 0.7898, of which 16 values are lower than the average;(2) Among the 30 poverty-stricken counties, the pure technical efficiency of poverty alleviation funds in 15 counties is 1, and the average value of pure technical efficiency is 0.9670, while the pure technical efficiency of poverty alleviation funds in 10 counties is lower than the average level; (3) From the perspective of average scale efficiency, the average scale efficiency of the use of financial poverty alleviation funds in 30 poverty-stricken counties involved in the study is 0.8168, and the use of poverty alleviation funds in more than half of counties shows increasing returns on scale.Conclusion:In poverty-stricken counties, the overall efficiency of the use of financial poverty alleviation funds is not high, among which the pure technical performance of input and output of financial poverty alleviation funds is relatively low. Therefore, under the same investment, more detailed and differentiated capital investment projects should be built to improve the efficiency of resource investment. For some counties with declining returns to scale, poverty alleviation projects with different characteristics can be added to improve the overall efficiency of poverty alleviation funds in counties.

Key words: financial poverty alleviation funds; use efficiency; DEA super-efficiency model;pure technical efficiency;

INTRODUCTION

Since the implementation of large-scale poverty alleviation and development in China in 2013, 700 million rural poor people have been lifted out of poverty, and the poverty alleviation goal has changed from solving the problem of food and clothing to building a well-off society in an all-round way. According to the National Rural Poverty Monitoring Survey conducted by the National Bureau of Statistics of China, at the end of 2019, there were 5.51 million rural poor people in the country, a decrease of 11.09 million or 66.8% over the end of the previous year, and the incidence of poverty was 0.6% or 1.1 percentage point lower than that of the previous year, including 470,000 rural poor in the eastern region, a decrease of 1 million over the previous year. Financial poverty alleviation has always been an important part of precise poverty alleviation strategy because it plays a unique role in enhancing poverty alleviation, poverty alleviation and wealth for poor families.

However, with the shift and upgrade of China's economy, the economic income gap between urban and rural residents in China is widening due to the factors of internal stratification and different levels of resources owned by poor areas. Finance, in essence, is integration, accommodation, sharing and common prosperity. The weakening of local government's financial ability leads to the growth rate of inter-regional financial aid-the-poor investment being faster than its economic growth rate, which aggravates the uneven development of local government's financial resources.[1,2] How to build a relatively scientific-oriented financial poverty alleviation investment model through the transfer of central financial poverty alleviation, that is, how to improve the incoordination between financial poverty alleviation investment model and economic development efficiency, has become an urgent problem to be solved in poverty-stricken areas, thus providing reference for other countries in fighting poverty.

LITERATURE REVIEW

First of all, 2280 papers on financial poverty alleviation included in China's CNKI journal database from 1987 to 2019 are taken as samples, and the current situation, stages, hot spots and evolution of domestic financial poverty alleviation research are sorted out. It is found that the current domestic financial poverty alleviation research can be divided into four stages, namely, the embryonic stage (1987-1993), the exploration stage (1994-2000), the deepening stage (2001-2010) and the outbreak stage (2011-2019), covering the core themes of operation mode, work performance, micro-credit, inclusive finance, innovation path, dilemma and countermeasures.

Judging from the publication time of the literature, the research on financial poverty alleviation has shown a growth spurt after 2011, and the highly cited literature was mainly published after 2014, when the high-frequency keyword also changed to targeted poverty alleviation (frequency of 553), financial poverty alleviation (frequency of 402), finance (frequency of 277), poor households (frequency of 256), poverty alleviation and development (frequency of 117), filing cards (frequency of 91), inclusive financing (frequency of 85), poverty alleviation (frequency of 123), etc. Besides, the number of links between the key words is extremely dense, indicating that the domestic financial poverty alleviation research has entered a "hot" stage.

Although the People's Bank of China has formulated theIndex System for Evaluating the Effect of Financial Poverty Alleviation Policy, which has not yet been put into operation, it is made only from the perspective of financial institutions, neither covering the related situation of financial precision poverty alleviation nor the public value consideration of financial precision poverty alleviation policy effectiveness. Yang J, Wu Y, Wang J, et al.[3] are the most representative ones in evaluating the poverty alleviation effect of county finance in China. They selected 9 cities (counties) where the national-level poverty-stricken counties in Hunan Province are located as samples, and used DEA－Tobit model to evaluate and analyze the performance level and

efficiency influencing factors of financial poverty alleviation from 2010 to 2015. The relevant results show that there are great differences in financial poverty alleviation efficiency among different cities in Hunan Province, Yueyang and Shaoyang have higher financial poverty alleviation efficiency, while the other seven sample cities (counties) have much room for improvement in financial poverty alleviation efficiency. At the same time, they also found that the level and efficiency of rural financial development, the preferential rural industrial structure and the support of the corresponding government fiscal policies are the main factors affecting the financial poverty alleviation efficiency at present. In this study, Shandong Province, a typical agricultural province in China, is selected as a research sample, and all its relatively poor counties and cities are concerned to study how to build a relatively scientific-oriented financial poverty alleviation investment model through the transfer of central financial poverty alleviation, so as to improve the uncoordinated relationship between the previous financial poverty alleviation investment model and economic development efficiency.

METHODS

In this study, Data Envelopment Analysis (DEA) is adopted, which is an efficiency measurement method that transforms a nonlinear program into a linear program to solve the problem, overcomes the shortcomings of traditional efficiency measurement methods, especially has advantages in multi-objective output problems.[4-6]

In DEA model, CCR model can rank the efficiency of decision-making units without considering the returns of scale, which is more in line with the model of this study. Therefore, input-oriented CCR model is adopted in this study.

Firstly, DMU units are set as analysis objects with m input variables $x_i(i=1,2\ldots\ldots,m)$ and s output variables $y_r(r=1,2,\ldots\ldots,s)$. At this point, the efficiency of the specific DMU unit analysis object DMUk is the ratio value of the output variable set to the input variable set as shown in formula (1).

$$\max h_k = \frac{\sum\limits_{r=1}^{s} u_r y_{rk}}{\sum\limits_{i=1}^{m} v_i x_{ik}} \quad \ldots\ldots (1)$$

$$s.t. \ \frac{\sum\limits_{r=1}^{s} u_r y_{rk}}{\sum\limits_{i=1}^{m} v_i x_{ik}} \leq 1$$

$$u_r \geq \varepsilon > 0, \ v_i \geq \varepsilon > 0$$

Where v_i and u_r are the weight vectors of each input variable and output variable. The formula (1) is converted into the linear programming multiplier formula (2) because the fractional programming model is nonlinear and the calculation is complicated.

$$Max h_k = \sum\limits_{r=1}^{s} U_r y_{rk} \quad \ldots\ldots (2)$$

$$s.t. \ \sum\limits_{i=1}^{m} V_i x_{ik} = 1$$

$$\sum\limits_{r=1}^{s} U_r y_{rj} - \sum\limits_{i=1}^{m} V_i x_{ij} \leq 0$$

$$U_r \geq \varepsilon > 0, \ V_i \geq \varepsilon > 0$$

Finally, it is transformed into Envelopment Model (3).

$$Max[\theta - \varepsilon(\hat{e}^T s^- + e^T s^+)] \quad \ldots\ldots (3)$$

$$s.t. \ \sum\limits_{j=1}^{n} x_j \lambda_j + s^- = \theta x_{j0} \ \sum\limits_{j=1}^{n} y_j \lambda_j - s^+ = y_{j0}$$

$$\lambda_j \geq 0 \ j=1,2, \ldots,n$$

When the model meets $\theta_0 = 1$ and $s^-=0, s^+=0$, DMU efficiency index is calculated. Otherwise the input variable scale of ineffective DMU unit needs to be reduced or the output scale needs to be increased to improve efficiency.

DEA efficiency evaluation method uses linear programming method to get input weight when dealing with various inputs and outputs, which can avoid the error of results caused by human factors. In

addition, the efficiency evaluation through DEA model can focus on the measurement of individual decision-making units, rather than the overall average, which can clearly reflect individual differences.[7] Pure technical efficiency reflects the use and management level of financial poverty alleviation funds (PAF), while scale efficiency reflects the impact of the scale change of financial investment in agricultural production and management on its output.[8] Specifically, it can be divided into three types: incremental return, constant and decrease. Comprehensive efficiency = pure technical efficiency* scale efficiency, so only when both pure technical efficiency and scale efficiency are effective can the overall efficiency and Pareto optimization be realized effectively.

MEASURES
Sample Selection

There are two reasons for choosing Shandong Province as a sample for study: (1) Shandong is a big economic and agricultural province, ranking third in GDP of all provinces in China in 2018, second only to Guangdong Province and Jiangsu Province, and the total agricultural output value of Shandong has been ranked first in China for many years. (2) Shandong Province has been rated as "excellent" in the performance evaluation of national financial special PAF, and has high efficiency of financial poverty alleviation, which shows that the sample selection of this study is typical and representative.

As of 2019, there are still 52 provincial counties with financial difficulties in Shandong Province, mainly concentrated in the southwest and northwest regions. Poverty-stricken counties accounted for 89% and the economic development was in a low level for a long time, mainly due to poor natural conditions and the lack of pillar industries. In this study, 30 counties and cities with severe poverty and short time to get rid of poverty were selected as the research objects.

Table 1
GDP of 30 Poverty-Stricken Counties in Shandong Province in 2019 (Unit: 100 Million CNY)

Counties	GDP	Counties	GDP	Counties	GDP	Counties	GDP
Wucheng County	216.13	Lijin County	245.00	Junan County	287.63	Pingyuan County	271.43
Lingxian County	295.23	Pingyi County	230.78	Feixian County	405.99	Wudi County	246.1
Dongping County	220.56	Yicheng District	141.33	Huimin County	210.1	Yinan County	220.56
Cangshan County	407.43	Dong'e County	166.84	Lingshan County	312.84	Wenshang County	216.21
Jiaxiang County	250.65	Shenxian County	392.24	Yangxin County	219.22	Qingyun County	185.00
Shanting District	113.98	Dongming County	220.00	Yuncheng County	435.3	Guanxian County	205.88
Caoxian County	434.00	Chengwu County	147.67	Shanxian County	375.00	Juye County	355.00
Dingtao County	207.00	Juancheng County	192.90				

Source: Communique on National Economic and Social Development of Counties and Cities in 2019

According to statistics, in 2019, the per capita net income of rural residents in 30 poor counties (districts) in Shandong Province was 14,970 CNY, far lower than the average level of 17,775 CNY in Shandong Province, and the income of residents in these poor counties and districts was mainly from planting and breeding, supplemented by young adults working outside the home.

In 2017, the Shandong Poverty Alleviation Office carried out a unified rectification of the allocation and management of special funds for poverty alleviation in various counties and cities in Shandong Province. Therefore, in this study, the original data of 30 poverty-stricken counties (districts) listed in Table 1 were selected as samples to build CCR efficiency model to measure the efficiency of financial targeted poverty alleviation.

Indicators

Input indicators

The input indicators were constructed in combination with the basic situation of the poverty-stricken areas in Shandong Province. The main indicators are as follows:

a. Financial investment in poverty alleviation: This indicator is directly measured by "the financial investment in poverty alleviation". Financial funds are one of the most critical factors to incite financial targeted poverty alleviation. The allocation and use of those funds can mobilize social resources and market forces, enlarge the efficiency of financial funds, and advance the coordinated development of financial institutions and industries by drawing upon the experience gained on key points, thus realizing the sustainability of financial poverty alleviation.[9] Therefore, "the amount of financial PAF invested by counties (cities) in that year" was used as the input indicator.

b. Population: "total registered population" was selected.

c. Fixed assets investment: in this paper, "sum of investments in fixed assets used" was taken as the input indicator based on the dimension of production function.

Output indicators

As showed in Table2, from the perspective of relative poverty, the output indicators of financial targeted poverty alleviation, including per capita disposable income (PCDI) of rural residents and regional GDP, are selected as the output indicators in DEA model.

Table 2 Input-Output Indicators		
	Dimensions	Name of indicators
Input indicators	Financial investment	Financial investment in poverty alleviation
	Human resources	Total registered population
	Fixed assets investment	Sum of investments in fixed assets used
Output indicators	Income level of farmers	PCDI of rural residents
	Regional economic growth level	Gross regional domestic product

RESULTS

In this paper, the input and output indicators of 30 districts and counties are selected according to the data of government websites involving counties and cities in Shandong Province in 2019 based on the efficiency measurement principle of DEA method, and the input-output model suitable for the performance evaluation of PAF in counties of Shandong Province is constructed. The Frontier Analyst 4.0 software was used to calculate the use performance of PAF in 30 poverty-stricken counties in Shandong Province, including comprehensive efficiency analysis (CCR model), pure technical efficiency analysis (BCC model) and scale efficiency analysis (SE model). The calculation results of the use efficiency of PAF in counties of Shandong Province are shown in Table 3.

Table 3
Results of Financial PAF Use Efficiency in 30 Poverty-stricken Counties and Districts of Shandong Province

Unit name	CCR Score	BCC Score	SE	RTS
Cangshan County (Lanling County)	0.5914	0.9528	0.6207	1
Caoxian County	0.5851	0.9977	0.5864	1
Chengwu County	0.5294	0.8914	0.5939	1
Shanxian County	0.6943	0.9314	0.7454	1
Dingtao County (Dingtao District)	0.7814	0.8567	0.9121	1
Dong'e County	1.0000	1.0000	1.0000	0
Dongming County	1.0000	1.0000	1.0000	0
Dongping County	0.6927	1.0000	0.6927	1
Feixian County	0.7836	1.0000	0.7836	1
Guanxian County	1.0000	1.0000	1.0000	0
Huimin County	0.6168	0.9815	0.6284	1
Jiaxiang County	0.7460	0.9870	0.7558	1
Juye County	0.7060	0.9376	0.7530	1
Liangshan County	0.6726	0.9304	0.7229	1
Lingxian County(Lingcheng District)	1.0000	1.0000	1.0000	-1

Ningjin County	0.8646	0.9821	0.8804	1
Pingyi County	0.5257	0.8906	0.5903	1
Pingyuan County	1.0000	1.0000	1.0000	-1
Qingyun County	1.0000	1.0000	1.0000	-1
Shanting County	0.7400	0.9194	0.8049	1
Wudi County	0.8341	1.0000	0.8341	1
Wucheng County	0.9005	1.0000	0.9005	1
Yangxin County	0.8065	0.9854	0.8184	1
Yinan County	0.5175	0.8594	0.6022	1
Yuncheng County	0.8443	1.0000	0.8443	1
Juancheng County	0.6831	0.9073	0.7529	1
Junan County	1.0000	1.0000	1.0000	-1
Shenxian County	1.0000	1.0000	1.0000	1
Yicheng District	0.8368	1.0000	0.8368	1
Wenshang County	0.7423	1.0000	0.7423	1
Mean	0.7898	0.9670	0.8168	1

Note: -1 means decreasing scale and 1 means increasing scale

Comprehensive efficiency of poverty alleviation

According to the test results, among the 30 poverty-stricken counties investigated, the overall comprehensive technical efficiency value of Dong 'e County, Dongming County, Guanxian County, Lingxian County (Lingcheng District), Pingyuan County, Qingyun County, Junan County and Shenxian County is 1, indicating that the DEA in the above counties is effective with the efficiency accounting for about 27.6% of the total, which also reflects that the allocation and utilization of input-output factors in these eight counties have achieved relative performance in PAF. The comprehensive efficiency of the other 22 counties is less than 1, which indicates that the overall comprehensive efficiency of the use of PAF in other counties is still on the low side, and the performance of DEA evaluation has not reached a relatively effective level. Among them, the comprehensive efficiency of Wucheng County is close to 1, which can be improved by referring to the test results of input-output indicators of the use of PAF in counties of Shandong Province to achieve a relatively effective DEA performance.

Judging from the average value of the comprehensive efficiency, the average comprehensive efficiency of the use of PAF in the counties of Shandong Province is 0.7898, and the values of 16 counties are lower than the average value, accounting for about 55.2% of the total, i.e. the comprehensive efficiency of more than half of the counties does not reach the average value of the

sample, and the overall comprehensive efficiency is low.

The distribution of comprehensive technical efficiency in the use of financial PAF in 30 poverty-stricken counties and districts in Shandong Province is shown in Figure 1.
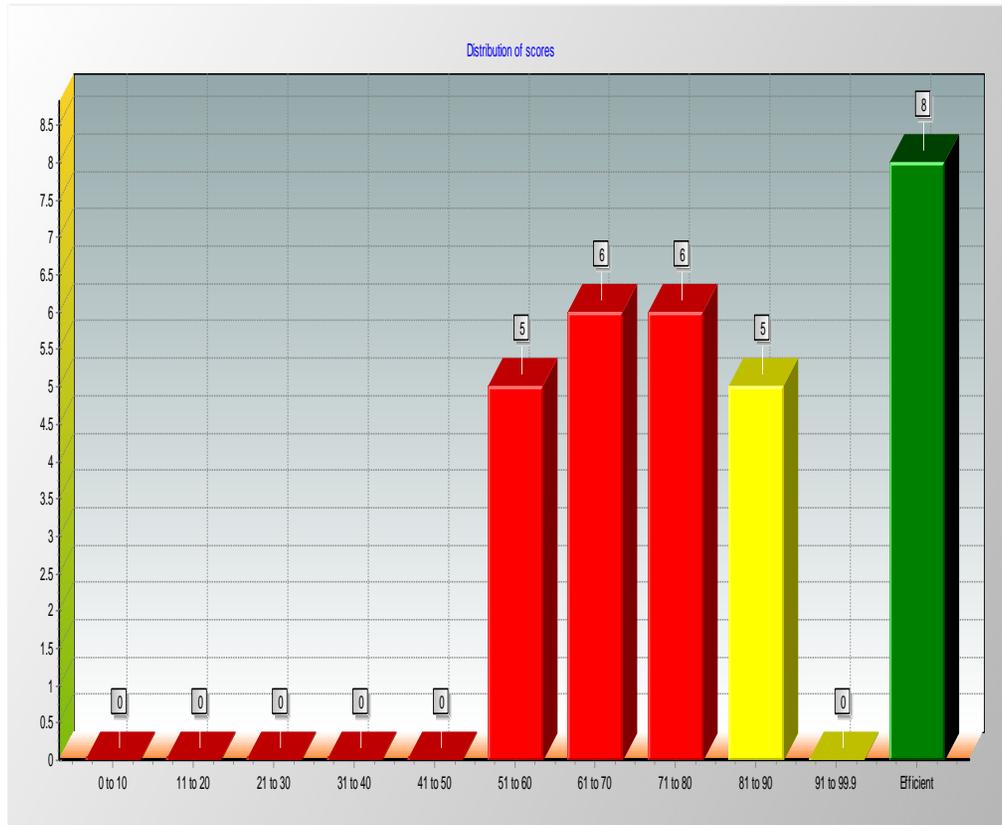

Figure 1 Comprehensive Technical Efficiency of Financial PAF in 30 Poverty-stricken Counties and Districts of Shandong Province

Pure Technical Efficiency of Poverty Alleviation

According to the test results in Table 3, the pure technical efficiency of PAF in 15 counties including Dong 'e County, Dongming County, Dongping County, Feixian County, Guanxian County, Lingxian County (Lingcheng District), Pingyuan County, Qingyun County, Junan County, Shenxian County, Yicheng District, Wenshang County, Yuncheng County, Wudi County and Wucheng County is 1, indicating that the PAF used in these counties are more efficient and the combination of various resource elements is better. The pure technical efficiency of PAF in other 14 counties is less than 1. Judging from the average pure technical efficiency, the average pure technical efficiency of PAF in counties is 0.9670, and the value of 10 counties is lower than the average, which indicates that the performance of using input-output pure technical PAF in such counties is relatively low. Therefore, under the same input, diversified projects for PAF in counties of Shandong Province should be built according to different types of consumption demands to improve the efficiency of resource input. The distribution of pure technical efficiency of financial targeted poverty alleviation in 30 poverty-stricken counties in Shandong Province is shown in Figure 2 below.
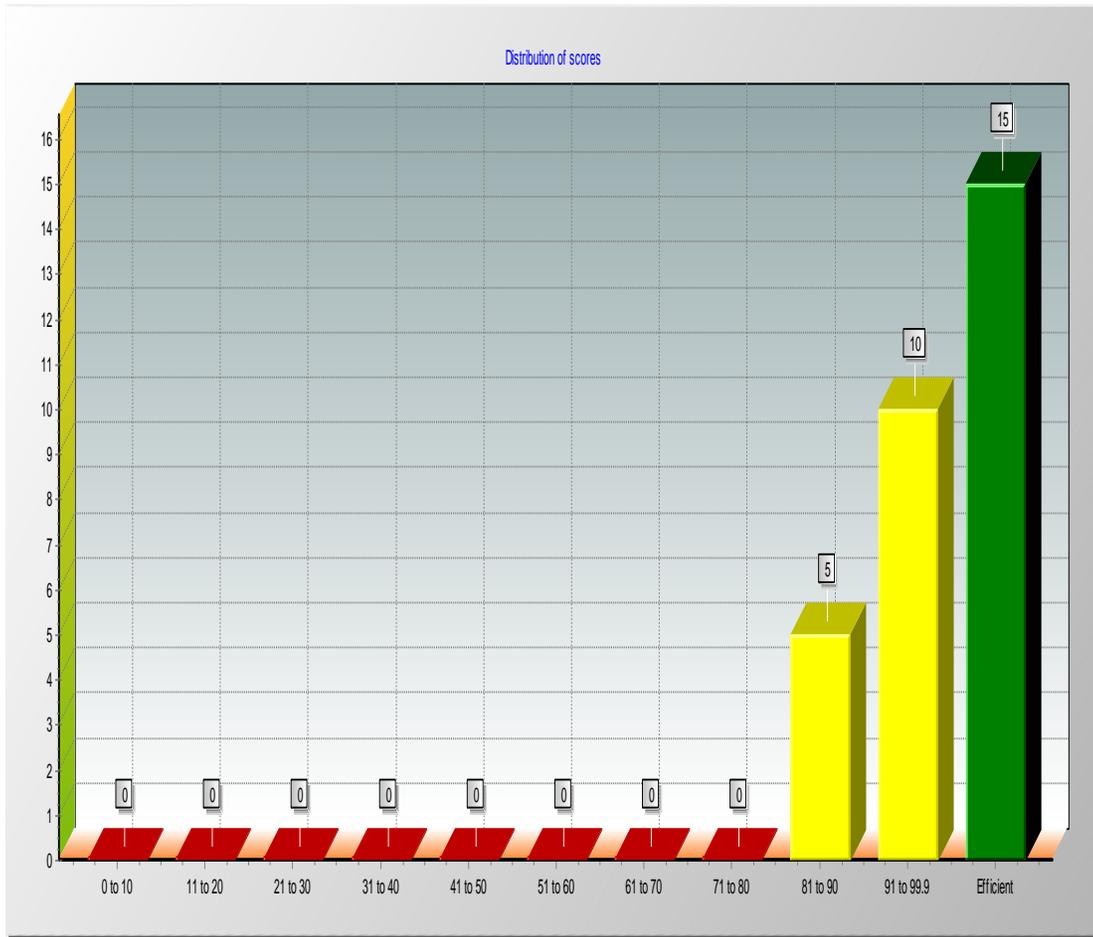
Figure 2 Distribution of Pure Technical Efficiency of Financial PAF in 30 Poverty-stricken Districts of Shandong

Scale Efficiency and Scale Return

According to the test results in Table 3, 8 counties in Shandong Province have achieved the best scale efficiency in the use of PAF: Dong 'e County, Dongming County, Guanxian County, Lingxian (Lingcheng District), Pingyuan County, Qingyun County, Junan County and Shenxian County. Judging from the average scale efficiency, the average scale efficiency of county PAF in Shandong province is 0.8168, and the value of 15 counties is lower than the average. From the perspective of returns on scale, there are 24 counties with increasing returns on scale in the usage of funds, indicating that these 24 counties will receive a larger proportion of returns if they increase the quantity of all input products in the same proportion. These counties have relatively low scale income due to relatively low investment.

Therefore, the use of PAF in these counties needs to be appropriately increased. The results show that there are two counties with diminishing returns on the scale of use of funds, indicating that the output growth rate of these two counties will be less than the increase rate of input after the increase of input, i.e. the output efficiency of project input is relatively low, which may be due to the overinvestment of human, material and financial resources in projects using PAF in one of these counties, and the homogeneous competition in projects using PAF in the other of these counties, as well as the failure of related resources to meet the optimal structure configuration to meet the consumption demands at different levels.

DISCUSSION

The results of using traditional DEA model to analyze the efficiency of the use of financial PAF in

30 poor counties in Shandong Province show that the DEA comprehensive efficiency is relatively effective in several counties, i.e. the measured value is 1. In order to further analyze the efficiency value of relative effective units, DEA super-efficiency model can be used to test the use of PAF in counties of Shandong Province, by effectively ranking Dong 'e County, Dongming County, Guanxian County, Lingxian County (Lingcheng District), Pingyuan County, Qingyun County, Junan County and Shenxian County. For the use of PAF in counties with ineffective DEA, the super-efficiency calculation results are consistent with those obtained by CCR, a classical DEA model.

According to the constructed input-output index of county financial PAF, it is found that at the provincial level, there is room for improvement; at the input level, the investment factors such as the arrangement of PAF, the total population and the sum of investments in fixed assets used all have investment redundancy; at the output level, PCDI of rural residents and regional GDP have great room for improvement, among which PCDI of rural residents can increase by 37.96% and regional GDP can increase by 34.65%.

CONCLUSIONS

In this paper, derived from the basic efficiency measurement principle of DEA method, an input-output model of PAFperformance evaluation is constructed, and then the data published by the government of 30 poverty-stricken counties in Shandong Province are selected and used to calculate the relative efficiency of PAF according to the indicators, and those following research conclusions are drawn:

The average comprehensive efficiency of financial PAF in 30 poverty-stricken counties in Shandong is 0.7898, among which 16 values are lower than the average, and 21 counties are relatively ineffective, indicating that the overall efficiency of funds in poverty-stricken counties in Shandong is not high.

Among the 30 poverty-stricken counties involved in the study, the pure technical efficiency of PAF in 15 counties is 1, with an average of 0.9670, and that in 10 counties is lower than the average level, which shows that the pure technical performance of PAF in poverty-stricken counties in Shandong is relatively low, so more detailed and differentiated capital investment projects should be built under the same investment to enhance the input use efficiency.

According to the average scale efficiency, the average value is 0.8168, and more than half of the counties show increasing returns to scale, that is, on the whole, more than half of the poverty-stricken counties in Shandong Province can increase the overall use efficiency of PAF by increasing poverty alleviation projects with different characteristics. However, in some counties, returns to scale are diminishing, probably because of over-investment in manpower, material resources and financial resources to a certain extent in the project investment of PAF, or homogeneous competition in projects using PAF in the other of these counties, as well as the failure of related resources to meet the optimal structure configuration.

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