Evaluation of the Performance of Financial Support for Agriculture in Guizhou Province Using Secondary Relative Benefit Model Based on DEA

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Abstract We use the secondary relative benefit model based on DEA to evaluate the performance of agricultural financial expenditure in Guizhou Province, which can give due consideration to the production effectiveness determined by objective natural conditions, and management effectiveness of all regions (as decision-making body) in the use of financial fund for supporting agriculture. In general, there is north-south gradient difference in the performance of financial support for agriculture between regions in Guizhou Province. The drought in 2010 has significant impact on the technical efficiency in the whole province; the performance score of each item in Liupanshui City and Southwest Guizhou is very low; the technical efficiency and management efficiency in most regions need to be improved. In order to improve the performance of financial support for agriculture, we need to ensure the scale of input; at the same time, provide appropriate preferential financial policies for agricultural infrastructure, especially the construction of rural water conservancy, development and promotion of agricultural science and technology, and other fields; adopt the way of special check and acceptance of supporting projects to strengthen the use management of the fund for agriculture.

Key words Financial support for agriculture, Performance evaluation, Secondary relative benefit model based on DEA

1 Introduction

Agriculture is the basic sector of the national economy, and also a weak industry, which needs the strong support of the government's finance in order to develop well. In recent years, the scale of China's agricultural financial expenditure has been constantly expanding, and researches on the performance of financial support for agriculture have captured domestic scholars' close attention. Li Huanzhang *et al.* (2004) verified the mutually causal relationship between increase in financial support for agriculture and agricultural output growth, and measured the marginal output effect of various kinds of financial expenditure on agriculture (in descending order: three fees for agricultural science and technology; expenditure for the agricultural infrastructure construction; expenditure for supporting rural production; operating expenses in departments of agriculture, forestry, water and gas). Wang Kuiquan (2003) proposed to improve allocation pattern of financial fund for supporting agriculture, input pattern and disbursement pattern, for enhancing the efficiency of government expenditure on agriculture. Cui Yuanfeng *et al.* (2004, 2006) believed that deviation in the structure of financial support for agriculture was the most important reason for low-level operation of holistic performance; proposed to implement project management and improve the systematicness in behavior of supporting agriculture. Li Xiangyun *et al.* (2010) found that the technical efficiency of financial support for agriculture in the western regions was low, and the overall efficiency in the eastern and central regions was significantly higher than that in the western regions, using provincial data.

Guizhou Province is located in the west, where the level of economic development is not high, the application of agricultural technology is insufficient, and the regional differences in agricultural development are obvious. The reason is as follows: on the one hand, due to different geographical conditions, there is a great disparity in the level of agricultural production efficiency; on the other hand, the effect arising from government's agricultural financial expenditure is different in different regions. Production effectiveness is not the same as management effectiveness, and the use efficiency of financial fund for supporting agriculture will differ due to different basic conditions in each region. For the evaluation of performance of financial support for agriculture in Guizhou Province, we should not only analyze the yield and extent that achieve the relative expected effect from production effectiveness, after using financial fund to support agriculture in the process of agricultural production, but also take into account the production behavioral characteristics stemming from each region's operation and management of the fund for agriculture, after eliminating the quality of objective basic conditions, to evaluate the performance of financial support for agriculture in each region.

In this paper, using the secondary relative benefit model

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based on DEA, we evaluate the production effectiveness and management effectiveness of financial support for agriculture in Guizhou's nine prefecture-level cities, and put forward countermeasures and recommendations for enhancing efficiency in support for agriculture based on this.

2 Research ideas and steps

Using data envelopment analysis (DEA) in non-parametric method, we can effectively overcome the restrictions of assumed condition arising from the specific functional form, and flexibly choose the number of variables to measure the technical efficiency of production, based on actual research needs. It has been widely used in economic management. On the basis of DEA method and Farred Measurement Method, the secondary relative benefit model developed by Feng Yingjun and Li Chenghong (1995) can reasonably measure the management efficiency of the decision-making unit.

In the use of secondary relative benefit model based on DEA to evaluate performance of financial support for agriculture, the first step is to determine the performance evaluation indicator system of financial support for agriculture. This article takes nine prefecture-level cities in Guizhou Province as decision-making units, "developing agricultural production, increasing farmers' income, increasing the grain yield" as the principle, to determine agricultural financial expenditure as the input; total agricultural output value, per capita net income of rural households, and grain yield as the indicator system of output.

The second step is to use BCC model to determine "base period benefit" and "current benefit", based on the input and output indicators of financial support for agriculture in each region, accordingly getting the technical efficiency value that can reflect "production effectiveness" of financial support for agriculture in each region. For the elimination of abnormal value in technical efficiency in a given area in a given period, drawing on the method advanced by Fu Runmin *et al.* (2008), we take the mean of technical efficiency in the base period and the current period, as the overall technical efficiency value.

The third step is to regard the technical efficiency of variable returns to scale of financial support for agriculture in the base period and the current period in all regions as input and output, respectively; estimate the management efficiency value reflecting the "management effectiveness", using secondary relative benefit model. The fourth step is to use the objective weighting method to synthesize "technical efficiency" and "management efficiency" of financial support for agriculture, so as to get the comprehensive efficiency for assessment of the performance of financial support for agriculture.

3 Research method

3.1 Determining of production effectiveness Production effectiveness is to examine the extent to which each region uses the minimum agricultural financial expenditure to achieve desired goals from the perspective of static pure technique. Assuming that we conduct performance evaluation of financial support for agriculture of i regions ($i=1,2,\ldots n$, signifying the number of decision-making unit (DMU). The input of each region is one-dimensional vector X_i, and the output of each region is j-dimensional vector $Y_i=[y_{1i}, y_{2i}, \cdots, y_{ji}]^T$, where X_i signifies per capita fiscal spending on agriculture in region i; Y_{ji} signifies the per capita output in region i.

According to the classic BCC model, we can use linear programming to express the technical efficiency of financial support for agriculture in region i as follows:

$$\theta_{i0}=\min\{\theta \mid \sum_{i=1}^{n}\rho_i X_i \leqslant \theta X_{i0},\ \sum_{i=1}^{n}\rho_i Y_i \geqslant Y_{i0},\ i=1,2,\cdots,n,\ \sum_{i=1}^{n}\rho_i=1,\ \rho_i\geqslant 0\} \quad (1)$$

where X_{i0}, Y_{i0} and θ_{i0} signify the input vector, output vector and technical efficiency value of i_0 DMUs to be assessed, respectively; ρ_i is the weight; expression (1) signifies the extent to which DMUs use the minimum input to achieve the given output. Let t = P, C be the base period and current period, respectively, from expression (1), we can derive that the technical efficiency score of DEA of financial fund for supporting agriculture, in the base period and current period in region i, is θ_i^p, θ_i^c, respectively, denoted by "base period benefit" and "current benefit" of financial support for agriculture in the region. We use the mean of "base period benefit" and "current benefit" to calculate the technical efficiency value α_i of each region, then $\alpha_i=1/2(\theta_i^p+\theta_i^c)$.

3.2 Determining of management effectiveness From the dynamic point of view, the management effectiveness is used to reflect the effort of each region in improving the effectiveness of financial fund for supporting agriculture. According to the secondary benefit model, the base period benefit θ_i^p and the current θ_i^c of financial support for agriculture in each region are regarded as input and output, respectively, and then we can establish new linear programming BCC model:

$$h_i=\max\{h \mid \sum_{i=1}^{n}\rho_i\theta_i^p \geqslant \theta_{i0}^c,\ \sum_{i=1}^{n}\rho_i\theta_i^p \leqslant \theta_{i0}^c,\ \sum_{i=1}^{n}\rho_i=1,\ i=1,2,\cdots,n\} \quad (2)$$

where ρ_i is weight. Let h_i be the optimal value of DMU i calculated according to expression (2), then the management efficiency of financial support for agriculture in region i is $\beta_i=1/h_i$.

3.3 Determining of the overall efficiency In order to synthesize "technical efficiency" and "management efficiency" into overall efficiency, we need to address the problem of weight assigning. The coefficient of variation can better eliminate the mean difference of "technical efficiency" and "management efficiency", reflecting the variation degree of unit mean data. We first calculate the coefficients of variation of the two, and then use the coefficients of variation to determine the weight of "technical efficiency" and "management efficiency" as μ_α and μ_β, respectively. Finally the overall efficiency of financial support for agriculture in all regions is synthesized as .

4 Empirical analysis

According to the evaluation model of performance of financial support for agriculture previously established, we use the input-output data concerning financial support for agriculture in Guizhou's 9 prefecture-level cities in 2009 and 2010, to get the base period benefit and current benefit of all regions by DEAP2.1 software, as is shown in Table 1.

From the estimation results in Table 1, there are two areas (Zunyi City and Bijie City) which score 1 point in terms of the technical efficiency of financial support for agriculture among Guizhou's 9 regions in 2009. The linear combination of financial input to agriculture in the two regions, establishes the forefront of based period technical efficiency. The technical efficiency of Guiyang City and Miao and Dong Autonomous Prefecture in Southeast Guizhou is low (0.663), while the technical efficiency of other five regions is at the middle level. Compared with 2009, the region scoring 1 point in terms of technical efficiency was only Zunyi City in 2010, followed by Bijie City. Except Guiyang City and Zunyi City, the technical efficiency score of the other seven regions shows decline to different degrees; there is a great fluctuation in the base period benefit and current benefit of all regions, the provincial average falling by 4 percentage points, and the decline in the technical efficiency of Liupanshui City and Buyi and Miao Autonomous Prefecture in Southwest Guizhou is most obvious, which may be closely related to the huge losses of agriculture arising from hundred-year severe drought disaster that ravaged many areas of Guizhou Province in 2010. The drought in Liupanshui City and Buyi and Miao Autonomous Prefecture in Southwest Guizhou is severe. This shows that agriculture, as a weak industry, is vulnerable to natural disasters, thus strengthening the construction of water conservancy infrastructure is of great significance to ensuring agricultural production stability, which should be unremittingly regarded as the focus of financial input into agriculture.

Table 1 Regional benefits

Region	Base period benefits in 2009	Benefits during 2010
Guiyang City	0.663	0.836
Liupanshui City	0.855	0.670
Zunyi City	1	1
Anshun City	0.875	0.784
The Tongren area	0.829	0.833
Buyi and Miao Autonomous Prefecture in Southwest Guizhou	0.732	0.602
The Bijie area	1	0.975
Miao and Dong Autonomous Prefecture in Southeast Guizhou	0.663	0.641
Buyi and Miao Autonomous Prefecture in South Guizhou	0.809	0.728
Mean	0.825	0.785

Data source: *Guizhou Statistical Yearbook* in 2010 and 2011.

On the basis of estimates of the base period benefit and current benefit, we further calculate the value of technical efficiency and management efficiency, as is shown in Table 2. Consistent with previous data, the technical efficiency score of Zunyi City ranks first in the province, followed by the Bijie area; the technical efficiency score of Liupanshui City, Miao and Dong Autonomous Prefecture in Southeast Guizhou, Buyi and Miao Autonomous Prefecture in South Guizhou, is at low level in the province; the technical efficiency score of the other four regions is at middle level. This situation objectively reflects the gradient differences in the geographical natural environment and agricultural development level of various regions in Guizhou Province.

Table 2 Single efficiency

Region	Technical efficiency	Management efficiency
Guiyang City	0.750	1
Liupanshui City	0.763	0.621
Zunyi City	1	0.793
Anshun City	0.830	0.711
The Tongren area	0.831	0.797
Buyi and Miao Autonomous Prefecture in Southwest Guizhou	0.667	0.652
The Bijie area	0.988	0.773
Miao and Dong Autonomous Prefecture in Southeast Guizhou	0.652	0.767
Buyi and Miao Autonomous Prefecture in South Guizhou	0.769	0.714
Coefficient of variation	0.153	0.144

From the management efficiency, the management efficiency score of Guiyang City is the highest, reflecting that Guiyang City has strong ability to manage financial fund for supporting agriculture; the management efficiency score of Bijie and Zunyi is still at the upper level in the province, but their technical efficiency score greatly outshines the management efficiency, indicating that the two places should focus on improvement in the management level of financial fund for supporting agriculture, and pursue the management efficiency along with the realization of production effectiveness; as against the technical efficiency, the management efficiency of Anshun City, the Tongren area and Buyi and Miao Autonomous Prefecture in South Guizhou, declines to some extent, but the management efficiency of Miao and Dong Autonomous Prefecture in Southeast Guizhou is significantly improved; compared with other regions, the management efficiency score of Liupanshui City and Buyi and Miao Autonomous Prefecture in Southwest Guizhou is significantly low, still at low level in the province, thus we should be alert to this.

Table 3 Classification of the overall efficiency

Type	Region (overall efficiency)
1	Zunyi City(0.900)
2	The Bijie area(0.884) Guiyang City(0.871) The Tongren area(0.815)
3	Anshun City(0.772) Buyi and Miao Autonomous Prefecture in South Guizhou(0.742) Miao and Dong Autonomous Prefecture in Southeast Guizhou(0.708)
4	Liupanshui City(0.694) Buyi and Miao Autonomous Prefecture in Southwest Guizhou(0.660)

Through objective weighting method, we calculate the comprehensive efficiency score of financial support for agriculture in all regions, and divide it into four types according to the score interval distribution, as is shown in Table 3. The comprehensive efficiency score of Zunyi City is the highest in whole province (0.900), belonging to the first-class regions, where the natural condition is good, the level of agricultural development is high and the level of managing financial fund for supporting agriculture is also high. The comprehensive efficiency score of Bijie, Guiyang, and Tongren is more than 0.8, belonging to the second-class regions, where the natural condition is slightly inferior to that of the first-class regions, and the management of use of financial fund for supporting agriculture is rel-

atively good. In the second-class regions, the natural condition is common, production effectiveness and management effectiveness both have large room for improvement, including Anshun City, Buyi and Miao Autonomous Prefecture in South Guizhou, and Miao and Dong Autonomous Prefecture in Southeast Guizhou. The fourth-class regions are represented by Liupanshui City and Buyi and Miao Autonomous Prefecture in Southwest Guizhou, where the natural condition is poor, and the management efficiency of use of financial fund for supporting agriculture ranks poorly in whole province.

5 Conclusions and recommendations

In summary, this article argues that there are north-south gradient differences in the agricultural natural conditions, and performance of agricultural financial expenditure. Whether it is the single score or composite score of the efficiency, the northern regions are significantly higher than the southern regions, and there is also regional disparity in agricultural economic development. The drought in 2010 has significant impact on the technical efficiency in the whole province. On the one hand, it is the manifestation of weakness characteristics of agriculture; on the other hand, it reflects the weak ability of agriculture to resist drought. Specifically, in terms of the use of financial agricultural funds, some regions only achieve production effectiveness or management effectiveness, and in the majority of regions, the production performance and management performance are not high. In general, there is great space for promoting the efficiency of financial support for agriculture, especially in Liupanshui City and Buyi and Miao Autonomous Prefecture in Southwest Guizhou.

In view of the actual situation of efficiency of financial support for agriculture in various regions of the province and differences in the objective conditions between regions, we put forth the following policy recommendations.

(i) The stability of agricultural financial expenditure should be ensured, to effectively protect the development of weak agriculture. *Several Opinions of the State Council on Further Promoting Good and Rapid Socio-economic Development in Guizhou Province in* 2012 pointed out that on the basis of stabilizing grain production, Guizhou Province should further promote the adjustment of agricultural structure, actively develop industrial management, and take the road of efficient, high-quality, green, and organic modern agriculture. It is required to strengthen the basic position of agriculture in economic development, and effectively ensure the steady improvement of agricultural financial expenditure.

(ii) The funds for agriculture should be focused on improving the construction of agricultural infrastructure; promoting the construction of mini-water conservancy projects (small water cellar, small embankment, small barrage, small pumping station, and small channel). In accordance with the requirements and deployment of the State Council's Document No. 2 this year, it should construct a number of emergency water projects, improve the drought emergency response capacity, strengthen the management of water resources and water conservancy facilities, actively use the central fiscal transfer payment and the support of the central investment within budget for water conservancy construction in Guizhou Province, to effectively complete the water conservancy construction goals.

(iii) It should increase input to agricultural technology development and technology promotion; rely on scientific and technological innovation, take the improvement in land yield rate, resource utilization rate, and labor productivity as the basic objective, accelerate the construction of modern agricultural park based on the characteristics of different regions, implement efficient three-dimensional mountainous agricultural project, enhance the level of agricultural mechanization, and improve the technical efficiency of financial investment in agriculture.

(iv) The government should strengthen the management, organization and implementation of funds for agriculture, focus on performance test, and achieve the management innovation of financial fund for supporting agriculture, using the way of special check and acceptance.

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