Research on China Regional Level of the Cooperation Efficiency and Evolution Path of Fiscal Support and Financial Support for Agriculture Based on Four Stage Window-DEA

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Abstract. In the paper, the Four Stages Window-DEA which concerns both environmental factor and heterogeneity frontier is built. We use the model to analyze the spatial-temporal evolution path and influencing factors of the cooperation efficiency of fiscal and financial support for agriculture. The results are as follows: (1) When eliminating environmental factor and random factors, the basic pattern of cooperation efficiency distribution is changed. After 2011, the cooperation efficiency in the central-region is better than the western-region. (2) The results of Panel SFA model show that the level of economic development and urbanization level can be considered as a favorable external environment, while the nature disasters can play as a unfavorable external environment. (3) The results of Panel-Tobit model show that management and information construction is beneficial for cooperation efficiency, while the spillover effects of agricultural knowledge and negative effects of corruption are not obvious. In order to enhance the cooperation efficiency, we propose some useful suggestion in the end.

Introduction

Agriculture is the foundation industry of national economy. For centuries, the Central Committee of Chinese Communist Party has attached great importance to the issues of agricultural production, therefore put an emphasis on agricultural supporting and invest a fortune in its production activities. There are two organically integrated parts of supports for agriculture, which are fiscal support and financial support. If one of them is separated from the other, the remaining condition will easily lead to trouble[1]. In literature, the theory of “cooperation efficiency of fiscal and financial support for agriculture” has been widely recognized. For instance, Jiang Song(2013)[2] and his co-authors used Markson index to measure the efficiency of fiscal and financial support for agriculture, and later shifted to use GARCH model to analyze the dynamic evolution of cooperative efficiency. In addition, Han Zhanbing (2014)[3] pointed out that the fiscal support and financial support for agriculture in China’s eastern, central and western regions should be sorted in a descending order, which suggests the data of eastern provinces were obviously higher than those of the central and western provinces. The relative ranking of provinces in terms of fiscal and financial support investment in agriculture is asymmetry, and the correlation between these two supports is apparently not high. Shi Dan and Yan Gao(2015)[4] conducted an empirical research with DEA method showing that the efficiency of fiscal support for agriculture is relatively high, its financial support is lower, and the efficiency of their coordinated supports appear to be the lowest.

However, these studies fail to analyze the dynamic evolutionary characteristics and influencing factors of its efficiency at the same time. In this paper, we decide to combine the three-stage DEA, window DEA and Tobit DEA together to construct a four-stage window DEA model for the analysis of the efficiency of fiscal and financial support for agriculture.
Construction of Four-stage Window DEA Model

The first stage: Window-DEA

In the first stage, DEA-BCC model is used to measure the efficiency. Since the efficiency values of different frontier faces are not comparable, this paper presents how to measure dynamic efficiency of Window-DEA. Specifically, the window-DEA model compares the decision-making units with the leading edge of the fixed-width window, and achieves the comparability of the efficiency in terms of time sequence among all decision-making units. Moreover, the choice of window width is the first step of Window-DEA model analysis. And we adopt Charnes et al. (1994) [5]'s idea by setting window width to be 3 or 4 in order to balance the reliability and stability of efficiency values.

The second stage: Quasi-SFA model

Since relaxation variables can reflect the initial inefficiency, in the second stage, we mainly focus on the relaxation variables. Without any artificial treatment, the data should include the influence of environmental factors, management inefficiency and statistical noise. Because of this concern, we adopt the SFA regression and decompose these relaxation variables into the above three effects.

The third stage: Window-DEA

At the third stage, we use DEA model to analyze the adjusted input-output variable. Similarly, Window-DEA model is adopted to get the efficiency value of decision-making unit after eliminating environmental factors and random factors. At this point, the efficiency data of the DEA homogeneity assumption become relatively objective and accurate.

The forth stage: Panel Tobit regression

The efficiency of the Window-DEA measure is between 0 and 1, revealing typical truncation characteristics. Through the analysis of influence factors for efficiency, if the ordinary OLS regression method is adopted, a large deviation may occur. We choose to use special statistical characteristics of Tobit regression as it is clearly a better choice to deal with truncated variables. As a result, in the fourth stage of this research, we adopt Tobit regression to discover the influential factors in the fiscal and financial coordination context.

Variable Selection and Data Sources

In this paper, China's regional panel data from the period of 2005 to 2013 is used to analyze the efficiency and influence factors of fiscal and financial coordinated support. In order to maintain the objectivity of research results, the data sets of Hong Kong, Macao and Taiwan are not included in the sample collection due to their missing information.

Input - output variable

Granting fiscal funds and providing financial funds are two main channels to support agricultural development. Based on the advantages of the above methods, we propose a coordinated approach to combine these two channels together and maximize their usefulness. Han Zhanbing (2014) pointed out that coordination between them can generate synergies effects and its manifestation is obvious: financial funds will expand channels for fiscal support afterwards, and fiscal funds help financial support avoid debt risk. Thus, the input indicators should be the combination of both fiscal funds and financial funds for agriculture support.

The economic purpose of fiscal and financial agriculture support is to promote agricultural industrialization, develop related science and technology, improve farmers’ income and eventually to achieve the prosperity of rural economy. According to Jiang Song(2013) et al., agricultural modernization level, agricultural economic growth and increase in farmers’ income are selected as three main indexes as the production output indicators.
External environment variable and internal management factors

According to the previous study, we select Level of economic development, Industrial structure, Natural climate, Level of urbanization as external environment variable, and Agricultural knowledge and skills, Management level, Informatization level, Support agriculture corruption as internal management factors. The above indexes and data sources are summarized in Table 1:

Table 1. Index system of the experiment.

<table>
<thead>
<tr>
<th>Index</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Indicators</strong></td>
<td>Fiscal funds for agriculture, Financial funds for agriculture</td>
</tr>
<tr>
<td><strong>Output Indicators</strong></td>
<td>Agriculture modernization, Growth of agriculture, Economic Increasing income of peasants</td>
</tr>
<tr>
<td><strong>Environmental factors</strong></td>
<td>Economic Development Level, Industrial Structure, Natural climate, Urbanization level</td>
</tr>
<tr>
<td><strong>Internal management factors</strong></td>
<td>Agriculture knowledge and skills, Management level, Information level, Agricultural Corruption</td>
</tr>
</tbody>
</table>

Experiment Setup and Result Analysis

The first stage: Window-DEA

With DEA-SOLVER Pro5.0 software, we set the window width \( d \) equal to 3 and measure the efficiency of provincial fiscal and financial coordination support in China from 2005 to 2013. Without removing environmental factors and random disturbance term, the synergistic efficiency in 2005 was 0.369. During the period from 2005 to 2013, the efficiency of fiscal and financial coordination support had experienced a slow growth. When comparing across different regions, we find that the tradition economic ranking pattern is “Eastern>Central>Western”. As always, the eastern region achieved the highest level of cooperation efficiency, followed by the central and western region consecutively. The synergistic efficiency of eastern region reveals a growing trend, while that of central and western region was still experiencing the regular pattern of fluctuation.

The second stage: Quasi-SFA model

As mentioned above, the assumption of DEA efficiency variable does not eliminate the environmental factors or random disturbance elements, so that it does not match the homogeneity premise of the decision making unit, which will cause the DEA efficiency measured in the first stage to be inaccurate. In order to remedy this limitation and approach the state of “ceteris paribus”, we set a second stage test and construct a new panel SFA regression model. At this time, the slack variable of the input in the first stage is regarded as the explained variable, the external environment variable as the explanatory variable. The test results are shown in Table 2.
Table 2. The empirical result of the second stage.

<table>
<thead>
<tr>
<th>Slack Variable</th>
<th>Fiscal Support for Agriculture Funds</th>
<th>Financial Support for Agriculture Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant Term</td>
<td>-7.809***</td>
<td>6.937***</td>
</tr>
<tr>
<td>The Level of Economic Development</td>
<td>-0.028*</td>
<td>-157**</td>
</tr>
<tr>
<td>Industrial Structure</td>
<td>21.82*</td>
<td>23.76</td>
</tr>
<tr>
<td>Natural Climate</td>
<td>0.034*</td>
<td>0.376**</td>
</tr>
<tr>
<td>Level of Urbanization</td>
<td>-21.364*</td>
<td>-12.679***</td>
</tr>
<tr>
<td>( \sigma^2 )</td>
<td>408.978***</td>
<td>217.980***</td>
</tr>
<tr>
<td>( \gamma )</td>
<td>0.437***</td>
<td>0.689***</td>
</tr>
<tr>
<td>( \eta )</td>
<td>0.028***</td>
<td>0.000</td>
</tr>
<tr>
<td>LR unilateral error</td>
<td>72.231***</td>
<td>13.896***</td>
</tr>
</tbody>
</table>

Note: ***, **, * respectively, at 1%, 5%, 10% significant level significant, the same below;

As follows, we discuss impacts of environmental variables on input slack variables, in the context of the fiscal and financial funds for agricultural support: (1) Level of economic development. The result indicates that if the local economy is more developed, this place will be more favorable to gather high-quality resources, and to promote agricultural economic development and agricultural modernization, thus enhancing the synergy efficiency. (2) Industry structure. The result indicates that the industrial structure has a weak negative effect on the cooperative efficiency. The possible reason is that the industrial structure is measured by the ratio of the added value of the secondary industry to the total added value. The higher the ratio is, the more important the secondary industry status can be. That is to say, agriculture sector is ignored, which results in low efficiency of policy agriculture support. (3) Natural climate. The result indicates the occurrence of natural disasters can indeed reduce the efficiency of fiscal and financial coordinated agricultural support, which is in line with our theoretical expectation. (4) Level of urbanization. The result indicates urbanization will help enhance the efficiency of fiscal and financial coordinated support in agriculture. The possible explanation is that, with the ongoing of urbanization, agricultural population are gradually migrating to cities, making the allocation of agricultural production factors reasonable, so as to enhance the synergy efficiency.

The third stage: Window-DEA

\[ X_{ni}^A = X_{ni} + [\max(f(Z_i; \hat{\beta}_x)) - f(Z_i; \hat{\beta}_x)] + [\max(v_{ni}) - v_{ni}] \quad i = 1, 2, \ldots, I; n = 1, 2, \ldots, N \]  

Where \( X_{ni}^A \) is the adjusted input; \( X_{ni} \) is the input before the adjustment; \( [\max(f(Z_i; \hat{\beta}_x)) - f(Z_i; \hat{\beta}_x)] \) is the adjustment of the external environmental factors; \( [\max(v_{ni}) - v_{ni}] \) is to put all the decision making units at the same level of luck.

According to the adjustment results, using DEA-SOLVER Pro5.0 software, we consider DUM scale returns as variables, set the window width \( d=3 \), and measure the efficiency of provincial fiscal and financial coordination support after eliminating environmental and random factors in China from 2005 to 2013.
Figure 1. The Third Stage: Evolution of Fiscal and Financial Coordination Efficiency.

Figure 1 depicts the trend of regional fiscal and financial coordination of supporting agriculture efficiency after eliminating environmental factors and random factors in China. Among them, the eastern region has the highest value of coordination efficiency. During the sample study, it showed typical “U” type reversal characteristics, suggesting that the eastern region does have a relatively high level of management. The initial coordination efficiency of the central region is the lowest and western region is centered. Both the central and western regions experience a significant decline in efficiency, and the declining trend in the western region is more pronounced. In 2011, the efficiency value of the central region is higher than that of the western region, but there are still big differences compared with the eastern region. Since the environmental and random factors have been removed, the efficiency values at this time reflect the true level of management skills.

In order to reflect the changes in the efficiency of fiscal and financial coordination, the efficiency change is represented by a horizontal axis (divided into efficiency reduction area, efficiency unchanged area, efficiency increase area), the vertical axis represents the initial efficiency value (divided into low, medium and high three areas) to construct a "GE matrix", thus the efficiency of China's fiscal and financial support for agricultural coordination is divided into nine types, shown in Figure 2.

Figure 2. The Layout Map of the Growth Trend and Initial Efficiency Value of Fiscal and Financial Support for Agriculture Coordination in Different Provinces and Cities.
The forth-stage: panel Tobit regression

In theory, after removing environmental and stochastic factors, the efficiency in the third stage should be limited only to internal management factors. The influence factors of coordination efficiency are analyzed by Tobit model, and the results are shown in Table 4. We can see that the coefficient of agricultural knowledge and skills is positive but insignificant, indicating that the role of agricultural knowledge and skills has not yet been fully exerted. The coefficient of management level is positive, and significant at the 5% level, indicating that agricultural management contributes to the coordination efficiency. The coefficient of informatization level is positive, and significant at the 1% level, indicating that in the process of fiscal and financial support for agriculture, information efficiency is improved. The coefficient of support agriculture corruption is negative, but insignificant, indicating that support agriculture corruption has a certain negative impact on the support efficiency, but the negative impact is not obvious.

Table 3. The fourth stage panel Tobit regression results.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient value</th>
<th>Std.Error</th>
<th>T Value</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant Term</td>
<td>0.9438***</td>
<td>0.2013</td>
<td>4.69</td>
<td>0.000</td>
</tr>
<tr>
<td>Agricultural knowledge and skills</td>
<td>0.0302*</td>
<td>0.0218</td>
<td>1.38</td>
<td>0.167</td>
</tr>
<tr>
<td>Management level</td>
<td>0.0500**</td>
<td>0.0206</td>
<td>2.43</td>
<td>0.015</td>
</tr>
<tr>
<td>Informatization level</td>
<td>0.0382***</td>
<td>0.0077</td>
<td>4.98</td>
<td>0.000</td>
</tr>
<tr>
<td>Support agriculture corruption</td>
<td>-5.1377</td>
<td>23.9477</td>
<td>-0.21</td>
<td>0.830</td>
</tr>
</tbody>
</table>

Policy Suggestions

Based on the above conclusions, we propose the following two suggestions:

First, the improvement of external environment is beneficial to enhancing the coordination efficiency of fiscal and financial support for agriculture, which can promote agricultural modernization and increase farmers' incomes. Specifically, government at all levels should be committed to regional economic development and speed up the process of urbanization. In addition, the government needs to take measures on disaster prevention and mitigation, to avoid adverse effects as a result of negative external environment on the coordination efficiency of fiscal and financial support for agriculture.

Second, it is the more realistic choice of improving internal management level that enhances the coordination efficiency of fiscal and financial support for agriculture. The simple reason is that internal management is controllable for the decision-making unit while external environment is not. In particular, the decision-making unit should enhance the management level and informatization construction of agricultural projects, and give full play to spillover effects of agricultural expertise, and eliminate the potential corruption for agricultural support.

References


