Analysis of rural financial service efficiency in major grain producing areas

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Abstract. This paper was based on the panel data of 13 provinces in China's main grain producing areas from 2005 to 2015, this paper analyzed the rural financial service efficiency of China's main grain producing areas by using super-efficiency DEA model, window Malmquist index and exploratory spatial data analysis. The study shows that the rural financial service efficiency of major grain producing areas in China is in a stable and effective state as a whole. The growth of total factor productivity is mainly due to the improvement of technical efficiency. There is a positive spatial correlation between the rural financial service efficiency of major grain producing areas.

1. Introduction
To improve the efficiency of rural financial services is the most important priority in rural financial development. It is not only related to the effectiveness of supply-side structural reform in agriculture but also about the strategic goal of building a moderately prosperous society in China. In recent years, with the support of China's agricultural policies, the development of agriculture had made a great progress and a new challenge. Rural finance is an important part of "agriculture, rural areas and farmers", and also the weakest link in China's financial system. The main cause of rural financial problems is the improper allocation of rural financial resources. To this end, China has carried out continuous rural financial reform. During the "two sessions" in 2016, general secretary Xi Jinping pointed out that in the current new form, the principal contradiction of China's agriculture has changed from a total shortage to a structural contradiction featuring periodic oversupply and shortage of supply.

Financial efficiency has always been the focus of theoretical research. An important index to measure rural financial development is rural financial efficiency. To improve the efficiency of rural financial services and realize full coverage of rural financial services is an important policy objective of China's rural finance under the New Deal. With the deepening of research, more and more scholars have conducted research on financial development level evaluation and financial efficiency measurement. As an important part of financial development level, financial efficiency is concerned and measured by many scholars at home and abroad. By increasing financial support, the differentiation phenomenon of financial development level in various regions in China has been gradually improved and began to shift to balanced development. The standards to measure the level of financial development are no longer focusing on scale effect, but on structural optimization and improvement of financial efficiency.
2. Research methods and data description

2.1. Research methods

(I) Super-efficient DEA model

The idea of using the super-efficient DEA model for research and analysis is as follows: excluding the decision unit to be evaluated. Compared with the traditional DEA model, in terms of the invalid decision unit, the production frontier with which it refers remains unchanged, so the efficiency value obtained by the super-efficiency DEA model is the same as that obtained by the traditional DEA model. As for the effective decision making unit, the production frontier it refers to will move back, so the efficiency value obtained by the super-efficiency DEA model will be higher than that obtained by the traditional DEA model. Under the traditional DEA model, the efficiency value of the effective decision-making unit is 1, so the efficiency value of the effective decision-making unit under the super-efficiency DEA model is greater than 1.

(II) The Malmquist index

The Malmquist productivity index was first applied to the analysis of consumption change, which was proposed by Sten Malmquist in 1953. In this analysis method, the reasons for the change of productivity are divided into two parts: one part is the movement of production frontier, which is called technical change; The other part is the utilization rate of production technology, that is, the change of the distance between the production frontier and the actual output, which is called technical efficiency change. Both technological change and technical efficiency change can be calculated through the distance function, so the ratio of the distance function is used to calculate the input-output change relation between the base period t and t+1 to obtain the change of productivity. Fare, Grosskopf, Lindgren and Roos defined the Malmquist index as:

\[
M_0(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{\frac{D_0(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)}}{\frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_{t+1}(x_t, y_t)}} \quad (1)
\]

In the formula: \(D_0(x_t, y_t)\), \(D_{t+1}(x_{t+1}, y_{t+1})\) is the input distance function compared with the frontier technology according to the production point at the same time period (t and t+1); \(D_t(x_t, y_t)\), \(D_{t+1}(x_{t+1}, y_{t+1})\) respectively, the input distance function obtained according to the production point and the frontier technology in the mixing period. Malmquist productivity index can be divided into two parts: technical efficiency change and technical change. Technical efficiency change can be divided into two parts: pure technical efficiency change and scale efficiency change. Therefore, the formula can be rewritten as:

\[
M_0(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{S_0(x_t, y_t)}{S_{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_0(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} \times \frac{D_t(x_t, y_t)}{D_{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_{t+1}(x_t, y_t)} \quad (2)
\]

(III) Exploratory spatial data analysis (ESDA) method

By ESDA method for spatial data analysis, this paper use the method of efficiency of rural financial services in the areas of space layout is described, and measures the spatial correlation between the provinces rural financial service efficiency, the efficiency of rural financial services in the areas of spatial aggregation degree and difference degree were studied. The method has two levels of analysis. A global correlation analysis usually measured with Moran index I (Moran, 1950) and Geary index C (Geary1954); Another local spatial analysis was measured by G statistics, Moran scatter plots and LISA plots.

Spatial autocorrelation can be used to study whether there is significant correlation between rural financial service efficiency in major grain producing areas in China. Global Moran's I is mainly used to describe the spatial correlation and difference of rural financial service efficiency in the main grain-producing areas.

2.2. Variable selection and data source
Selection of investment indicators: this paper selects indicators from three aspects of human, material and financial resources as input of rural financial services. The number of rural financial institutions and the number of employees of financial institutions were selected as indicators reflecting the manpower aspect. This paper also considers the penetration of geographical and population services respectively, and selects the number of financial institutions' branches per 10,000 square kilometers, the number of financial employees per 10,000 square kilometers, the number of financial institutions' branches per 10,000 people and the number of Banks' employees per 10,000 people as input indexes. The total amount of rural fixed assets is selected as the indicator of material resources. The total amount of household fixed assets includes household fixed assets investment and rural non-household fixed assets investment. This paper selects the ratio of fixed asset investment to GDP and per capita fixed asset investment as input indexes. The indicators reflecting financial resources are the balance of agricultural loans and the expenditure of agricultural insurance premiums. This paper selects financial institutions' per capita agricultural loan balance, ratio of financial institutions' agricultural loan balance to GDP and per capita agricultural insurance premium expenditure as input indexes.

Output index selection: this paper selects the index to measure the output level of rural financial services from two aspects: rural economic development level and rural living level. Among them, per capita agricultural added value is taken as an indicator to reflect the level of rural economic development, which can reflect the per capita scale and speed of agricultural development. The rural per capita net income and rural per capita consumption expenditure are taken as indicators to reflect the living standards of farmers.

Data source: the data of the number of rural financial institutions and financial institution practitioners in 13 provinces in the main grain-producing areas from 2005 to 2015 were obtained from the China regional financial operation report of the people's bank of China in 13 provinces. The agricultural loan balance is derived from Guotaian database. Per capita agricultural added value, per capita rural net income and per capita rural consumption expenditure come from China statistical yearbook. The data of total investment in rural fixed assets comes from the statistical yearbook of China fixed asset investment.

3. Formatting the text
(I) static analysis of rural financial service efficiency.

Table 1: rural financial service efficiency of the provinces in the major grain-producing areas

| Province  | 2005  | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | Average |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| Anhui     | 1.503 | 1.045 | 1.129 | 1.193 | 1.308 | 1.121 | 1.093 | 1.130 | 1.040 | 1.010 | 1.050 | 1.147   |
| Hebei     | 0.664 | 0.589 | 0.530 | 1.087 | 0.674 | 0.475 | 0.473 | 0.465 | 0.521 | 0.492 | 0.493 | 0.587   |
| Henan     | 0.777 | 0.764 | 0.828 | 0.734 | 1.072 | 0.762 | 1.026 | 0.741 | 0.687 | 0.644 | 1.028 | 0.824   |
| Heilongjiang | 1.145 | 1.297 | 1.137 | 1.223 | 1.139 | 1.074 | 1.154 | 1.327 | 1.387 | 1.194 | 1.435 | 1.228   |
| Hubei     | 1.099 | 1.084 | 1.183 | 1.310 | 1.394 | 1.412 | 1.356 | 1.345 | 1.347 | 1.492 | 1.642 | 1.333   |
| Hunan     | 1.128 | 1.278 | 1.117 | 1.016 | 1.025 | 1.009 | 1.001 | 1.011 | 1.006 | 1.037 | 1.020 | 1.059   |
| Jilin     | 1.167 | 1.167 | 1.014 | 0.770 | 1.228 | 0.932 | 1.089 | 0.805 | 1.045 | 0.686 | 1.265 | 1.015   |
| Jiangsu   | 1.375 | 1.444 | 1.341 | 1.297 | 1.313 | 1.625 | 1.598 | 2.860 | 4.179 | 3.748 | 1.950 | 2.066   |
| Jiangxi   | 1.014 | 0.902 | 0.904 | 1.021 | 0.687 | 0.727 | 0.713 | 1.002 | 1.143 | 0.752 | 0.578 | 0.858   |
| Liaoqing  | 1.001 | 1.014 | 1.042 | 0.808 | 1.046 | 1.154 | 1.040 | 0.778 | 1.000 | 1.060 | 1.000 | 0.995   |
| Neimengu  | 1.067 | 1.164 | 1.150 | 0.817 | 1.026 | 1.083 | 0.804 | 0.625 | 0.638 | 1.076 | 1.061 | 0.955   |
| Shandong  | 0.658 | 0.651 | 0.682 | 0.694 | 1.422 | 0.670 | 0.574 | 0.551 | 0.592 | 1.005 | 0.544 | 0.731   |
| Sichuan   | 0.788 | 0.778 | 0.797 | 0.844 | 1.013 | 0.652 | 0.633 | 0.578 | 1.004 | 1.044 | 0.494 | 0.784   |
| Average   | 1.030 | 1.014 | 0.989 | 0.986 | 1.104 | 0.976 | 0.966 | 1.017 | 1.199 | 1.172 | 1.043 | 1.045   |
Figure 1 the mean value of rural financial service efficiency in the provinces of major grain-producing areas from 2005 to 2015.

Figure 2. Rural financial service efficiency of major grain-producing areas from 2005 to 2015.

13 provinces from 2005 to 2015 in the areas of 10 years, the rural financial service efficiency value as shown in table 1, the total can be seen that major grain producing areas and the provinces ten years the change trend of the rural financial service efficiency. Overall, 10 years, the rural financial services in the areas are effective, major grain-producing areas in 2005-2015 averages 1.045 a rural financial service efficiency, efficiency mean less volatile from year to year, and during the period of fluctuating around the mean, affected by the financial crisis in 2008. From the local perspective, it can be seen from figure 2 that there are significant differences in the efficiency of rural financial services in various regions of China's major grain-producing areas. The main production areas of the Yangtze river basin are of high efficiency, the main producing areas of northeast China are second, and the lowest is the main producing areas of Huanghuaihai.

From the perspective of individuals, from the longitudinal analysis of time series, in the case of a single province, the efficiency of rural financial services has not fluctuated significantly between 2005 and 2015, and fluctuated around the overall mean. From the horizontal analysis of the provinces, the difference of rural financial service level between the 13 provinces in China's major grain-producing regions is obvious.

From 2005 to 2015, the province with the highest average efficiency of rural financial services was Jiangsu Province. The efficiency value is 2.066, which is much higher than that of other provinces,
which is consistent with the actual situation in Jiangsu province. First, location is the space of rural financial service development. Jiangsu province is located in the coastal areas of China's eastern mainland, with convenient transportation and location gathering force. Secondly, the smooth and efficient operation of economy is the foundation of efficient operation of rural financial services. As a province with fast economic development in eastern China, Jiangsu has provided a solid foundation for its rural financial service development. Finally, science and technology is an important driving force for the improvement of rural financial service efficiency.

(II) dynamic analysis of rural financial service efficiency.

Table 2 lists the overall Malmquist productivity index and its decomposition of the main grain-producing areas in China.

| year | Total factor productivity(MI) | Technical efficiency(EC) | Advances in technology(TC) |
|------|-------------------------------|--------------------------|---------------------------|
| 2006 | 1.04                          | 0.96                     | 1.10                      |
| 2007 | 1.07                          | 0.99                     | 1.08                      |
| 2008 | 1.07                          | 0.95                     | 1.15                      |
| 2009 | 1.23                          | 1.24                     | 1.07                      |
| 2010 | 1.08                          | 0.89                     | 1.25                      |
| 2011 | 1.20                          | 1.01                     | 1.20                      |
| 2012 | 1.22                          | 1.08                     | 1.15                      |
| 2013 | 1.07                          | 1.15                     | 0.92                      |
| 2014 | 1.10                          | 1.07                     | 1.03                      |
| 2015 | 1.06                          | 1.00                     | 1.11                      |

Table 3 the Malmquist productivity index and its decomposition of rural financial service efficiency in the main grain producing areas of China.

| Province          | MI           | EC           | TC           |
|-------------------|--------------|--------------|--------------|
| Anhui             | 0.931753     | 0.916982     | 1.026774     |
| Hebei             | 0.988653     | 0.93384      | 1.133495     |
| Henan             | 1.050146     | 1.035462     | 0.998255     |
| Heilongjiang      | 1.162537     | 1.060002     | 1.105434     |
| Hubei             | 1.135876     | 1.062407     | 1.070616     |
| Hunan             | 1.059471     | 0.988474     | 1.073294     |
| Jilin             | 1.245959     | 1.105939     | 1.235543     |
| Jiangsu           | 1.377696     | 1.2078       | 1.193101     |
| Jiangxi           | 1.010842     | 1.009804     | 1.016788     |
| Liaoning          | 1.187875     | 1.016401     | 1.202429     |
| Neimenggu         | 1.195677     | 1.038167     | 1.185715     |
| Shandong          | 1.267734     | 1.146434     | 1.164746     |
| Sichuan           | 0.973938     | 0.997889     | 0.987929     |
| Main production area in northeast China | 1.198012 | 1.055127 | 1.18228 |
| Huang-huai-hai main production areas | 1.102178 | 1.038579 | 1.098832 |
| The Yangtze river basin | 1.081596 | 1.030559 | 1.061417 |

(III) analysis of spatial differences in the efficiency of rural financial services.

In figure 3 you can see, the efficiency of rural financial services in the areas of global
autocorrelation coefficients from 2006 to 2015 is on the rise, in addition to the 2008, 2009, two years is negative, other years are between 0 and 1. In 2008 and 2009, it was negative to show that the rural financial service efficiency space in the major grain-producing areas in the two years was negatively correlated, which was more dispersed and the spatial difference was large. It can be produced by the financial crisis in 2008, on the one hand, the outbreak of the financial crisis makes the provinces is facing huge economic downward pressure, on the other hand the provinces in the face of financial crisis compressive ability is different. Except for 2008, 2009, two years, other years Moran's I is positive, that efficiency of rural financial services in the areas exist space is positive correlation, and there is a certain degree of aggregation, but Moran's I still has a long way to numerical distance 1, prove that major grain producing areas of rural financial service efficiency of clustering is small, the overall spatial differences are diminishing trend, but there is a great distance from the comprehensive and balanced development.

Figure 3 the overall self-correlation coefficient of rural financial service efficiency in China's main grain producing areas.

4. Conclusion
Through to the efficiency of rural financial services in the areas of static analysis found that: first, overall, rural financial services in the areas in the study period was effective, less volatile from year to year, and was basically stable development state. Secondly, there is a certain gap in the development of different regions. Among them, the main producing areas in the Yangtze river basin and the main producing areas in the northeast are more efficient, and the yellow Huaihai region is relatively inefficient. In the end, the gap between the provinces is relatively large, and Jiangsu province is the first in the rural financial service efficiency due to its superior geographical location and relatively high level of financial development.

Through to the efficiency of rural financial services in the areas of dynamic analysis found that the efficiency of rural financial services in the areas of total factor productivity growth between 2005 and 2015, mainly because of the improvement of technical efficiency, technological progress also have certain effect, but the impact is less than the technical efficiency.

Based on the efficiency of rural financial services in the areas of spatial analysis found there is a positive correlation relationship in the efficiency of rural financial services in the areas, the regional rural financial service efficiency had a certain degree of aggregation, but had not have a high level of aggregation, correlation, but the present correlation is still not high, the efficiency of the overall rural financial service space difference decreases.

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