Influence of Agricultural Employee Behavior on Technical Efficiency of Farmers' Plantation -Empirical Research based on SFA Model

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Abstract: In order to explore the technical efficiency level and influencing factors of China's agricultural production, this paper measures the technical efficiency of farmers' plantation by stochastic frontier production function (SFA) based on the micro-data of CFPS in 2018, then analyzes the influence of agricultural employees' behavior on the technical efficiency of farmers' planting. It is concluded that the technical efficiency in the sample is 0.525, and the technical efficiency of farmers' households with employees is significantly higher than that of farmers' households without employees. It is hypothesized that this effect is due to both the operation scale and the awareness of the management of the households with hired labor.

Keywords: Technical Efficiency ; SFA; Agricultural Employee Behavior

1 Introduction

With the increase of population, the acceleration of urbanization, the continuous improvement of people's living standards and the change of food structure, the demand for agricultural products in China will continue to grow, and the resource constraints faced by agricultural production are becoming more and more obvious. It is not a long-term way to obtain higher output only by investing more production factors. It is necessary to focus on improving the ability of resource utilization and agricultural technology utilization, so as to obtain greater output under the condition of fixed input. The technical efficiency measures the extent to which the production unit can use the existing technology to achieve the maximum output from the perspective of input and output[1], which can reflect its output capacity, resource utilization efficiency and cost control[2].

2 Literature Review

In order to effectively promote the sustainable and healthy development of China's plantation, it's necessary to study the technical efficiency of planting production, so as to improve the technical efficiency of planting production according to local conditions and materials.

At present, Chinese scholars have conducted in-depth research on the technical efficiency of agricultural production.:

In studying the variations in technical efficiency across different periods, agricultural products,

and regions., Zhou Hong and others used DEA model to measure the production level of rice in China and analyzed the changes of its efficiency accordingly[3]; Zhang Dongping used DEA model to analyze the total factor productivity of wheat production in China since 1990s, and discussed the reasons for the decline of wheat production efficiency in China and the ways to improve it[4]. In a related study on the factors influencing the technical efficiency of agricultural production, Peter pointed out that subsidies have a significant negative impact on the technical efficiency of grain production in family farms by using the analysis of transcendental logarithmic stochastic frontier production function[5]; Huang Fenghua and others used DEA method to calculate the agricultural production efficiency and the main efficiency of agricultural production in Heilongjiang Province in recent 10 years, and pointed out that the comprehensive efficiency of grain production in semi-humid areas was the highest[6]; Jiang Changyi, through stochastic frontier analysis, highlights how agricultural productive services compensate for the direct technical efficiency loss among aging farmers.[7].

At present, the relevant research measures the technical efficiency from the macro and micro levels, aiming at different periods or regions, and points out the influence of land transfer, non-agricultural employment and other factors on technical efficiency. In addition to these factors, this paper considers that the family is the basic production unit of rural society[8], the impact of the production and management decisions of farmers' families on production efficiency is worthy of attention, Therefore, we have chosen to investigate the impact of farmers' household members participating in farming production on production efficiency at the micro level of farmers' families.

3 Model Setting and Data Description

3.1 Model Setting

This paper use stochastic frontier production function (SFA) to measure the technical efficiency of farmers' plantation.

The technical efficiency of production means that the utilization and allocation efficiency of production factors in the process of agricultural production is influenced by the established input structure and production mode, which reflects the ratio of actual output to maximum output[9]. Stochastic frontier production function (SFA) is a commonly used method to measure individual technical efficiency[10], the production frontier is estimated in the form of specific production function and the technical efficiency of production is determined based on this. Its original theoretical model is:

$$lnY_i = \beta_0 + \beta_i lnX_i + v_i - u_i$$

Y_i represents the actual output of the sample i and the input elements of the sample i (including capital, labor and other input elements); v_i is factors that the sample can't control in production, which is used to judge the measurement error and the effect of random interference, such as statistical error, the influence of climate and natural disasters, etc., and it

obeys the independent normal homo-distribution.$v_i \sim N\ (0,\ \sigma^2)$; u_i is the inefficient part of production technology, that is, the distance between sample output and production frontier, and u_i obeys a semi-normal distribution.

The expression of technical efficiency is:

$$TE_i = \frac{E(Y_i\ /\ u_i, X_i)}{E(Y_i\ /\ u_i = 0, X_i)} = exp(-u_i)$$

The technical efficiency TE_i is calculated by separating the inefficiency u_i from the mixed error term $v_i - u_i$. If TE_i equal to 1 means that the sample is in a state of complete technical efficiency, and the technical efficiency is on the production frontier, if not, the sample has a loss of technical efficiency, and the technical efficiency is below the production frontier.

3.2 Data Description

The data used in this paper comes from the survey data of the China Family Panel Studies(CFPS) in 2018.

The sample covers 25 provinces, and the respondents include all the family members in the sample households. In order to explore the production efficiency of farmers engaged in planting, the samples of farmers engaged in planting only (not engaged in other agricultural production activities) were retained, and 2,163 valid samples were obtained for descriptive statistics. Then, the missing and abnormal values were filtered out, and 1,665 valid samples were obtained for random frontier production function estimation.

The related variables used in this paper include the input-output variables of farming in 2018: the output variable selects the total value of agricultural and sideline products of farmers' families who are only engaged in farming activities; The labor input variables are two indicators: the number of people engaged in planting and the cost of hiring workers in planting. The capital input variables are seed pesticide and chemical fertilizer input and agricultural machinery input. At the same time, the external observation value is selected: whether the sample family hires additional workers to engage in their own planting production. The specific variables are explained in Table 1.

Table 1 Variable Interpretation

project	Variable name	Variable interpretation
Planting output	Total value of agricultural and sideline products in plantation	Total value of crops and by-products produced by oneself in 2018 (yuan)
Labor input	Number of households engaged in farming	Number of family members engaged in their own farming (persons)
	Employee input	Remuneration paid for hiring workers to engage in their own farming (yuan/year)

capital input	Seed pesticide and chemical fertilizer input	The cost of seeds (including the value of their own seeds), fertilizers and pesticides (yuan/year)
	Agricultural machinery input	The sum of the total value of agricultural machinery for self-use and the expenses paid for renting agricultural machinery (yuan/year)
External observation	Whether to hire workers	Whether to hire workers to engage in their own farming in 2018, yes =1, no =2.

Note: In the estimation of stochastic frontier production function (SFA), both input and output variables are in logarithmic form.

4 Empirical Analysis

4.1 Descriptive Statistical Results

Before measuring the technical efficiency, the level values of output and input and external observation indicators of 2,163 households only engaged in planting (no other agricultural production activities) were statistically described, and the results are shown in Table 2.

Table 2 Descriptive statistical results of input-output variables

Variable name	mean	S.D.	min	max
Total value of agricultural and sideline products in plantation	9289.493	23626.755	0	750000
Number of households engaged in farming	1.909	0.95	1	9
Employee input	918.579	5561.621	0	190000
Seed pesticide and chemical fertilizer input	4613.887	11286.638	0	200000
Agricultural machinery input	3963.97	14679.813	0	350400
Whether to hire workers	0.207	0.405	0	1

It can be seen that among the farmers who only engage in planting (no other agricultural production activities), the average total value of agricultural and sideline products in planting reached 9,289 yuan in 2018, and the production results of planting were considerable, while the total value of agricultural and sideline products of high-yield farmers could reach 750,000 yuan, which shows that there is a great difference in planting production capacity among sample farmers, and the problem of balanced agricultural development is obvious; In terms of labor input, among the farmers' family members, an average of two people will participate in their own planting production, while fewer families have additional employees.. Although the average cost of employing workers is 918 yuan, there is significant variation., and more families do not have additional employees' expenses, which is reflected in the fact that the average value of the binary variable "whether to hire workers" is only 0.207; In terms of capital investment, the investment in seed pesticides, fertilizers and agricultural machinery has shown a large degree of variation, and the capital investment of large-scale farmers has reached hundreds of thousands, which indicates significant variation in the scale of planting production among farmers.. In the subsequent estimation, 7 samples with inputs over 100,000 yuan were rounded to get more reasonable production efficiency.

4.2 Estimation Results of Stochastic Frontier Production Function

After screening out some abnormal values, the number of effective samples participating in the estimation of stochastic frontier production function is 1665. According to the variable of "whether to hire workers", it is divided into two groups: the employed group and the unemployed group, with 357 samples and 1308 samples respectively. The estimated results are shown in Table 3.

Table 3 Estimation Results of Stochastic Frontier Production Function

Logarithm of total value of agricultural and sideline products in plantation	（1）overall	（2）Employed group	（3）non-employed group
Logarithm of the number of households engage in planting	0.197***	0.242***	0.186***
	(0.042)	(0.093)	(0.046)
Logarithm of employee input	0.135***	0.213***	
	(0.031)	(0.04)	
Logarithm of seed pesticide and chemical fertilizer input	0.644***	0.513***	0.675***
	(0.021)	(0.048)	(0.023)
Logarithm of agricultural machinery input	0.126***	0.126***	0.123***
	(0.014)	(0.03)	(0.016)
Whether to hire workers	-0.757***		
	(0.231)		
constant term	3.374***	3.195***	3.144***
	(0.16)	(0.306)	(0.173)
Sample size	1,665	357	1,308
*** p<0.01, ** p<0.05, * p<0.1			

It can be seen that there is a significant positive correlation between the overall output of plantations and the input of capital and labor force.

In terms of capital investment, the impact of seed pesticide and chemical fertilizer input is the most obvious. In general, the elasticity of seed pesticide and chemical fertilizer input, such as output, is 0.644, which reaches 0.675 in the group without employees. In contrast, the elasticity of agricultural machinery input is only about 0.124 in the three groups of estimates. It can be inferred that the current plantation is limited in dependence on the use of agricultural machinery, and the purchase of seeds, pesticides and chemical fertilizers still constitute the main influencing factors of planting output, and the mechanization of agricultural production needs to be promoted.

In terms of labor input, the increase in output brought by family labor participation and extra employees is not as obvious as capital input. It can be seen that the flexibility of family labor

input in the employed group reaches 0.242, which is significantly higher than that in the overall and unemployed groups. It can be speculated that the farmers' families who will hire additional agricultural workers have a larger planting scale for their own families, so they are more dependent on the input of labor. Compared with families with saturated family labor, more labor can bring more efficient use, that is, every increase in a certain percentage of family labor input can bring a higher percentage of planting output.

Among them, the 0-1 variable "whether employees" significantly affects the planting output at the level of 1%, and the planting output of farmers' families with employees is 75% lower than that of farmers' families without employees. It can be speculated that the absolute value of the family size of the employee group is small, which limits the labor input and thus the absolute value of the output is small. Compared with the influence of employees on absolute planting output, the influence of employees' behavior on production technical efficiency is also worthy of attention.

4.3 Production Technical Efficiency Estimation Results

The results obtained by using SFA model to measure the technical efficiency of farmers' production are shown in Table 4.

Table 4 Estimation Results of Production Technical Efficiency

Technical efficiency	mean	min	max
Overall technical efficiency	0.525	0.008	0.891
Technical efficiency of employee group	0.702	0.016	0.925
Technical efficiency of non-employed group	0.543	0.008	0.896

It can be seen from Table 4 that the average technical efficiency of farmers' production is 0.525 on the whole. Although the technical efficiency of some farmers can be close to 0.9, there is still much room for improvement on the whole.

It is noteworthy that the average production technical efficiency of the employed group is 0.702, which is significantly higher than that of the unemployed group of 0.543. By plotting the distribution map of the two groups of farmers' production technical efficiency, we can more intuitively see the differences brought by employee behavior to farmers' production technical efficiency, as shown in Figure 1.
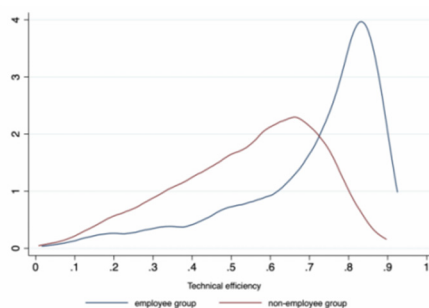

Fig. 1 Distribution map of technical efficiency of farmers' planting production in employee group and non-employee group.

Although the absolute output value of the employed group is not higher than that of the unemployed group, the production efficiency is obviously concentrated at a higher level: the peak value of the production efficiency in the employed group is higher than that of the unemployed group, and the employed group is between 0.8 and 0.9, while the unemployed group is between 0.6 and 0.7, and the unemployed group has a noticeably higher proportion of peasant households with low production technical efficiency compared to the employed group.

Although the absolute output value of the employee group is lower, the production efficiency of the employee group is significantly higher. In order to analyze the influence mechanism of agricultural employee behavior on technical efficiency, this paper makes the following speculation:

4.3.1 Employees' Families Have Relatively Large Planting Scale.

Farmers' families employ extra agricultural workers because the family labor force is not enough to meet their own agricultural production needs. Therefore, it is speculated that the employed families have larger planting scale (based on their own family size), more significant scale effect and higher production efficiency. This paper estimates the planting scale of farmers by considering their land assets., and the descriptive statistical results are shown in Table 5.

Table 5 Descriptive statistical results of family size and land assets

variable	Employed group		non-employed group	
	mean	S.D.	mean	S.D.
Family size (person)	3.937	1.848	4.05	1.919
Land assets (yuan)	67167.996	144266.74	27358.228	41494.719

It can be seen that the average family size of the employed group is 3.937, which is smaller than that of the unemployed group (4.05), while the average land asset is 67,167 yuan, which is much larger than that of the unemployed group (27,358 yuan), we can conclude that the employed families have a relatively larger planting scale..

Most studies have confirmed that there is a positive relationship between agricultural land management scale and production efficiency[11]. Employees' families can use agricultural machinery more conveniently in larger-scale agricultural production and improve their output with the same input; When the planting scale is larger, farmers have stronger bargaining power when purchasing seed fertilizers and other means of production, so as to control costs under the same output, which has a significant impact on improving technical efficiency. Zhou Xiaoshi and Li Gucheng also pointed out that farmers with smaller operation scale, human capital has a significant negative correlation with agricultural production efficiency. But after enhancing the scale, labor input has a significant promotion effect[12]. The conclusion is also in line with the speculation that the farmers with employees have higher labor input, thus have higher technical efficiency.

4.3.2 Employees' Families Have a Stronger Sense of Agricultural Management.

The practice of hiring agricultural workers for their own planting production reflects the farmer's adjustment of the agricultural production plan through human input. which can reflect the family's management awareness of agricultural production to a certain extent. This paper

roughly compares the management consciousness of the two groups of farmers through three indicators: the total value of agricultural machinery put into use, whether there is land for rent at home and whether there are people engaged in individual and private business at home. The descriptive statistical results are shown in Table 6.

Table 6 Descriptive statistical results of agricultural management consciousness

variable	Employed group		non-employed group	
	mean	S.D.	mean	S.D.
Total value of agricultural machinery (yuan)	5994.1	22864.898	3432.96	11573.331
Whether to lease the land (Yes =1, No =0)	0.137	0.344	0.107	0.309
Whether to engage in individual and private (Yes =1, No =0)	0.108	0.31	.073	0.26

It can be seen that the average total value of agricultural machinery invested by farmers in the employee group is 5994 yuan, which is significantly higher than that of the non-employee group of 3432 yuan, which is consistent with the speculation that the employee family has a larger planting scale, and also reflects that the employee family pays more attention to agricultural production planning and will improve the level of production mechanization and technical efficiency by investing more agricultural machinery and equipment;

At the same time, through the average value of 0-1 variable of "whether to rent land" and "whether to engage in individual and private", it can be seen that employees will rent more land and more often have family members engaged in individual and private. This kind of families often have higher awareness of risk management and family production and operation planning than other farmers' families, are more likely to accept new income-generating channels, and can better master, apply and improve existing technologies. Therefore, in the process of planting production, it is more likely that the families of hired farmers will have higher technical efficiency because of adopting more scientific production methods or reasonable planning of production and operation.

5 Conclusions and Suggestions

According to the estimated value of production technical efficiency, the production efficiency of plantation is significantly higher in the households with employees: the average production technical efficiency of all samples is 0.525, the average production technical efficiency of employees is 0.702, and the average production technical efficiency of non-employees is 0.543;

Based on the estimated values of production technical efficiency, results of stochastic frontier production function, it is found that the absolute output value of plantation is low in the peasant households with employees, presumably because the peasant households with employees are smaller and the family labor force is more limited;

Based on the above conclusions, this paper holds that, combined with the influence mechanism of employee behavior on production technical efficiency, we should take

advantage of appropriate policy incentives to encourage farmers to scale up and intensify production, and make rational use of existing technologies and resources to achieve scale effect, so as to control costs or expand output and improve technical efficiency; On the other hand, we should pay full attention to the cultivation of farmers' awareness of production management, improve farmers' planning ability of production and operation through talent introduction and education and training, gradually change some traditional and inefficient production methods, guide farmers to make full use of existing resources, enhance farmers' capacity to understand and apply existing agricultural technologies.

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