Efficiency Evaluation of Effect of Direct Grain Subsidy Policy on Performance of Rice Production

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Abstract Using the DEA analysis method, on the basis of the national panel data from 2002 to 2014, this paper made a comparative analysis on the rice production performance before and after the implementation of direct grain subsidy policy, and made an empirical analysis on the relationship between the direct grain subsidy policy and the changes in the rice production performance. The results showed that the effect of the direct grain subsidy policy on promoting the rice production performance is declining year by year, largely because drop of scale efficiency. Besides, there are problems of serious redundancy in agricultural subsidy, unreasonable resource allocation, leading to low performance and resource waste of rice production.

Key words Direct grain subsidy, Rice production performance, Scale efficiency, Pure technology efficiency, DEA

1 Introduction

Rice, as a major grain crop in China, plays a very important role in the grain production. Since the new century, the rice production in China underwent a process of first fall then rise. In 2000 – 2003, rice yield suffered a 4 consecutive years of decline. It dropped from 198 million t in 1999 to 161 million t in 2003, directly leading to widening gap between supply and demand of grain, threatening the national grain security and arousing close attention of the government. In order to reverse the decline in China's grain production, speed up the grain market reform, and increase the income of rice farmers, China implemented the direct grain subsidy policy in 31 provinces (municipalities and autonomous regions) in 2004. From 2004 to 2014, the rice yield achieved an astonishing 11 consecutive years of increase. From the dynamic changes of time, the marginal annual rice yield showed different degrees of decline. The rice yield of 2004 increased 18.432 million compared with the year 2003; in 2005, it increased 1.501 million t compared with the year 2004; in 2011, it increased 5.240 million t compared with the year 2010; in 2013, it decreased 0.624 million t compared with 2012. Due to the scarcity of agricultural resources and the seriousness of the destruction of the ecological environment, it is unrealistic to increase the growth of agricultural production on the basis of declining returns of resource scale. It is also unrealistic to simply rely on the production factors. Therefore, it is required to constantly increase the agricultural production efficiency and the growth of total factor productivity becomes the most important source of power for long-term growth of grain production. Therefore, it is necessary to study the efficiency evaluation of the direct grain subsidy policy in view of the rice production performance, so as to provide a scientific theoretical basis for improving the rice subsidy policy.

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2 Literature review

In 2004, China implemented the direct grain subsidy policy in 31 provinces (municipalities and autonomous regions). The policy has been constantly improved. At present, it has established the subsidies for grain farmers, agricultural means of production, fine seed, and large agricultural machinery and tools. Through review of the relevant literature, we found that most researches before 2008 thought that it is difficult to determine the subsidy objects and scope, and the subsidy method and subsidy calculation are complex, the subsidy amount is small, the execution cost is enormous, the subsidy standard is too low, and the difference between all areas is big, so it is required to take suitable measures in accordance with local conditions, improve the subsidy standards and supporting measures[9,15,16,18,22]. At present, there is still no consistent conclusion on the evaluation of the effect of direct grain subsidy policy, and the starting points are mainly grain security and farmers' income. On the one hand, some scholars believed that the direct grain subsidy policy directly stimulates the enthusiasm of grain farmers, increases the grain yield and farmers' income. Grain subsidy exerted a significant effect on increasing farmers' income[3]. If average subsidy level increased by 1%, the grain yield could increase 0.056%[21]; if the government increased one yuan for fine seed subsidy, farmers could increase the net income by at least 11 yuan[20]; the subsidy policy increased the yield through increasing the per unit area yield[24]. On the other hand, some scholars stated that the direct grain subsidy policy has no significant effect on farmers' grain production or agricultural inputs[2,11], it has little or no effect on increasing grain planting area[17], and it has no big effect on increasing farmers' income[5,22]. Chen Fengbo believed that the rice production subsidy policy plays a certain role in promoting rice production, but the utilization efficiency of rice production subsidy funds is to be improved[6]; Hong Zitong held that the evaluation of subsidy for purchase of agricultural machinery exerts no significant effect on farmers planting rice[10]; Guan Jianbo, using nonparametric Malmquist index method calculation results, stated that after the implementation of fine seed subsidy policy, the total factor productivity (TFP) of cotton in China is lower compared with that before the policy implementation, and technological progress loss is the main reason for decline of cotton TFP[8]; Li Gucheng found that different policy objectives have different policy effects, and it is required to increase the pertinence of the granting of subsidies[13]. The above researches focused on the overall effect of the direct grain subsidy policy on increase of grain yield and farmers' income. There are few researches on whether the direct grain subsidy policy will affect production performance and have not taken into account the changes in China's grain subsidy policy. In the convenience of calculation, the production performance refers to the total factor productivity (TFP)[14]. Therefore, on the basis of the above researches, using the DEA analysis method, we made a comparative analysis on the rice production performance before and after the implementation of direct grain subsidy policy, and made an empirical analysis on the relationship between the direct grain subsidy policy and the changes in the rice production performance.

3 Comparative analysis on the rice production performance before and after the implementation of direct grain subsidy policy

3.1 Data description The data for calculating the rice production performance was mainly selected from *Compilation of National Cost Benefit Data of Agricultural Products* (*2002–2014*). In this study, we only selected the cost and benefit data related to the unit area of rice variety. We calculated the total factor productivity (TFP) of rice and its composition using the DEA (data envelopment analysis) based Malmquist index method modified by Fare *et al.* (1994). For convenience of description, the rice production performance referred to the rice TFP.

3.2 Indicator selection (i) Output indicator. We took the yield of main rice products per unit area (kg/mu) as the output indicator because such treatment can make it consistent with the statistical caliber of the input indicator. The input caliber in existing statistical yearbook is based on the per unit area. Besides, it can eliminate the effect of area fluctuation on the output, and the yield of main rice products can reflect the degree of rice production technological progress better than the total yield. (ii) Input indicator: we took material cost and labor input in per unit area of rice planting as the input indicator. Since it is difficult to obtain reliable data about fixed asset stock in the agricultural production factor, we generally calculate individual input of chemical fertilizer, machinery, and irrigation cost. Earl O. Heady (1991) once stated that if there is no same material unit, different nature of capital input in agricultural production needs to be properly integrated, while magnitude of value is a suitable measurement method and convenient for calculation. With reference to existing researches, we used the material cost to integrate. Besides, it is necessary to convert the material cost input (yuan/mu) into the price of the year 1993. Labor input refers to the actual amount of labor input in the process of rice planting. The total labor time should be used to measure the contribution of the labor factor to the growth of the output. In this study, "the number of labor" is the "standard labor day", including the number of labor days used by producers and employees in production, and used as labor input indicator.

3.3 Comparative analysis of the rice production performance before and after the policy implementation The Malmquist index and its decomposition of rice TFP in China from 2002 to 2014 were listed in Table 1. On the whole, the average annual growth rate of rice TFP index in China was negative (−0.4%). From the composition of TFP growth rate, the technological progress had the average annual growth rate of 0.2%, while the technical efficiency index declined with an average rate of 0.6%, which leads to the decline of rice TFP. The total factor productivity index in 2004 was 1.082, which was the highest value of rice TFP in 2002–2014. The growth rate of rice TFP was 8.2%. The rice technology efficiency declined 7.2%, but the technological progress increased 16.4%. From 2004, China implemented the direct grain subsidy policy in 31 provinces (municipalities and autonomous regions).

However, from the point of view of the direct grain subsidy policy in 2002–2004, China's rice TFP index grew at an average annual rate of 2.3%, of which it kept a growth trend in both 2002 and 2004. However, after the implementation of direct grain subsidy policy, China's rice TFP did not rise but declined. In 2005–2014, the annual average decline rate was up to 1.3%. In these ten years, only 4 years had growth: 1.6% in 2006, 1.6% in 2007, 4.8% in 2009, 5.2% in 2014; other years suffered decline. In terms of total factor productivity, the technology efficiency dropped by 2.1% in 2002–2004, while the technology growth index increased by 4.8% annually, indicating that the growth of technological progress was the dominant factor in the growth of TFP at this stage. The technology progress and technology efficiency declined by 0.9% and 0.2% respectively in 2005–2014, which indicated that both of them were the reason for the decline of rice TFP after implementation of the direct grain subsidy policy. These needed to be further explored.

4 Efficiency evaluation of effect of direct grain subsidy policy on performance of rice production

4.1 Evaluation indicator system We still used DEA method to evaluate the efficiency of TFP growth after implementation of the direct grain subsidy policy. Taking the rice TFP index as output indicator, amount of subsidies for grain farmers, agricultural means of production, fine seed, and large agricultural machinery and tools as input indicator, and using the data of *China Agricultural Development Report* (*2002–2014*) and statistical data of Ministry of Agriculture and Ministry of Finance, we measured the effect of direct grain subsidy on the rice TFP growth.

(i) Output indicator. This mainly refers to the total factor productivity (TFP) index of rice, measured by the above mentioned Malmquist index method. It is important to note that since the rice TFP obtained by DEA is the chain change index of 1.000 in the previous year, which is in fact a variation, so we converted them into cumulative growth index taking the data in 2002 as 1.000. Finally, the result was used as the output indicator. Detailed results were listed in Table 2. (ii) Input indicator. We mainly selected the amount of subsidies for grain farmers, agricultural means of production, fine seed, and large agricultural machinery and tools as input indicator. To unify the caliber, we converted all data into the constant price, as listed in Table 2.

Table 1 DEA calculation results of rice TFP

Year	Technology efficiency (*Effch*)	Technology change (*Tech*)	Pure technology efficiency (*Pech*)	Scale efficiency (*Sech*)	TFP (*Tfpch*)
2002	0.988	1.027	1.010	0.979	1.015
2003	1.022	0.952	1.004	1.018	0.973
2004	0.928	1.164	1.000	0.928	1.082
Mean value of 2002 – 2004	0.979	1.048	1.005	0.975	1.023
2005	1.000	0.913	1.000	1.000	0.913
2006	1.008	1.007	1.000	1.008	1.016
2007	0.992	1.025	0.983	1.009	1.016
2008	0.986	0.961	1.017	0.969	0.947
2009	1.019	1.029	0.982	1.038	1.048
2010	0.980	0.982	1.019	0.961	0.962
2011	1.002	0.968	1.000	1.002	0.970
2012	1.005	0.977	1.000	1.005	0.981
2013	1.001	0.980	0.973	1.029	0.981
2014	0.989	1.064	1.001	0.989	1.052
Mean value of 2005 – 2014	0.998	0.991	0.998	1.001	0.987
Mean value of 2001 – 2014	0.994	1.002	0.999	0.995	0.996

Note: the mean value of 2002 – 2004 and mean value of 2005 – 2014 were calculated by geometric average.

Table 2 Data of all indicators Unit: 10^8 yuan

Year	Original value of rice TFP	Conversion index of rice TFP	Direct grain subsidy	Subsidy for agricultural means of production	Subsidy for fine seed	Subsidy for purchase of agricultural machinery
2002	1.015	1.000	0.00	0.00	1.00	0.20
2003	0.973	0.973	0.00	0.00	3.15	0.21
2004	1.082	1.052	127.89	0.00	31.42	0.77
2005	0.913	0.961	152.81	0.00	43.43	3.47
2006	1.016	0.977	172.60	145.86	50.49	7.29
2007	1.016	0.992	192.72	352.25	85.00	25.53
2008	0.947	0.940	202.35	854.98	165.37	53.60
2009	1.048	0.985	267.35	1063.77	279.31	182.92
2010	0.962	0.947	223.10	1233.67	301.40	228.86
2011	0.970	0.919	234.25	1334.14	271.48	263.73
2012	0.981	0.901	245.96	1755.95	325.78	350.21
2013	0.981	0.884	258.26	1831.78	340.36	372.00
2014	1.052	0.930	271.17	1923.36	385.12	426.52

Note: the subsidy amount for grain farmers, agricultural means of production, fine seed, and large agricultural machinery and tools was unified. Namely, all data were converted into the constant price of the year 2002.

4.2 Measurement of the efficiency of direct grain subsidy for rice production performance In this study, the scale of input indicator had large change. We adopted variable compensation BCC model to measure the efficiency of direct great subsidy for rice production performance, as listed in Table 3.

From Table 3, we can know that in the overall efficiency, the direct grain subsidy did not exert a good effect on promoting the growth of rice TFP in 2002 – 2014, the annual efficiency value was only 0.178, much lower than the optimal value of 1. In the past 13 years, the contribution rate of direct grain subsidy to rice TFP growth reached 1 only in 2002. In other words, the effect of direct grain subsidy policy on promoting the rice TFP growth reached optimal level in 2002. In addition, it can be seen from Fig. 1 that the effect of direct grain subsidy on the growth efficiency of rice TFP was roughly first decline then slowly getting stable, declining from 100% in 2002 to 92.7% in 2003, a significant decline to 2.7% in 2006, and later, it slowly declined and got to stable level.

Table 3 DEA measurement results of the direct grain subsidy policy for rice TFP

Year	Overall efficiency	Pure technology efficiency	Scale efficiency	Returns to scale
2002	1.000	1.000	1.000	–
2003	0.927	0.973	0.952	drs
2004	0.273	1.000	0.273	drs
2005	0.055	0.913	0.061	drs
2006	0.027	0.929	0.029	drs
2007	0.012	0.943	0.012	drs
2008	0.006	0.894	0.006	drs
2009	0.004	0.936	0.004	drs
2010	0.003	0.900	0.003	drs
2011	0.003	0.874	0.004	drs
2012	0.003	0.856	0.003	drs
2013	0.003	0.840	0.003	drs
2014	0.002	0.884	0.003	drs
Mean value	0.178	0.919	0.181	–

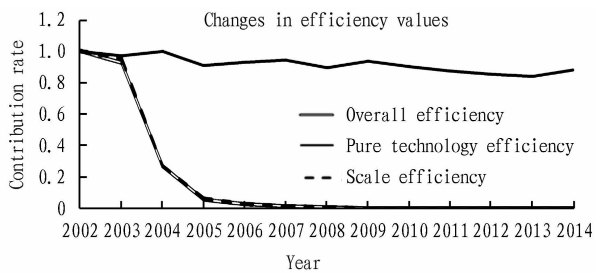

Fig. 1 Changes in the contribution rate of direct grain subsidy policy to rice TFP growth in 2002 – 2014

In terms of pure technology efficiency, the average annual performance was 0.919, but there was still some gap compared with the optimal value, indicating that the production factors of financial capital investment were not brought into full play in promoting the growth of rice TFP, and there might be problem of waste of resources. Only in 2002 and 2004, the allocation of production factors reached the optimal level. In general, in years without effective returns to scale (2003 – 2014), the average annual pure technology efficiency was 0.919, close to 1.000, while the annual average value of scale efficiency was 0.181, indicating that the rice TFP growth mainly relied on pure technology efficiency, rather than the improvement of the scale efficiency. Besides, the factor input did not reach the optimal level, there was blind input of direct grain subsidy, neglected the rational allocation of existing resources, leading to low performance and waste of resources in the rice production.

Table 4 The redundancy in input of direct grain subsidy Unit: 10^8 yuan

Year	Direct grain subsidy	Subsidy for agricultural means of production	Subsidy for fine seed	Subsidy for purchase of agricultural machinery
2002	0.000	0.000	0.000	0.000
2003	0.000	0.000	2.000	0.000
2004	0.000	0.000	0.000	0.000
2005	16.000	0.000	9.020	2.300
2006	26.000	120.000	13.040	5.300
2007	35.000	276.000	38.100	19.300
2008	35.000	638.000	94.900	39.300
2009	74.000	756.000	170.000	129.300
2010	35.000	835.000	175.500	154.200
2011	35.000	860.000	146.500	169.300
2012	35.000	1078.000	171.500	214.300
2013	35.000	1071.000	170.500	216.800
2014	35.000	1071.000	185.950	236.800
Mean value	27.769	515.769	90.539	91.300

4.3 Analysis on redundancy of agricultural subsidy input

Table 4 showed the degree of redundancy of rice subsidy input in 2002 – 2014. According to Table 4, in the past 13 years, there was no redundancy of direct grain subsidy only in 2002, 2003, and 2004, and there were different levels of redundancy in the remaining years. On the whole, in 2002 – 2014, the direct grain subsidy wasted 2.777 billion yuan, and agricultural means of production wasted 51.57 billion yuan, the fine seed and purchase of agricultural machinery wasted 9.054 billion yuan and 9.137 billion yuan. As to the distribution of redundancy in different years, the redundancy of fine seed subsidy was most serious, there was redundancy in 11 years; the years of redundancy in subsidy for purchase of agricultural means were fewer than other subsidies, but due to high subsidy amount, the redundancy was serious; the redundancy in the direct grain subsidy and the subsidy for purchase of agricultural machinery was better, each had no redundancy for three years respectively. In sum, there was serious waste of resources in the implementation of the current policy.

5 Conclusions

In sum, the effect of direct grain subsidy policy on promoting the efficiency of rice production performance is not strong, and the promotion effect takes on a declining trend, indicating that the existing direct grain subsidy policy fails to greatly promote the growth of rice production performance. As the pure technology efficiency is stable and close to the optimal level, and the fluctuation of scale efficiency is high and takes on a declining trend, the loss of scale efficiency is the dominant factor for decline in the effect of direct grain subsidy on promoting the rice TFP growth. The decline in the scale efficiency shows that in the process of subsidy for rice production, the subjectivity is high and the subsidy criteria are greatly different. Blind input leads to unreasonable allocation of elements, the direct grain subsidy policy fails to give into full play and the rice production performance is low. From the analysis of the redundancy of rice subsidy, it can be seen that there is a serious waste of resources in the implementation of the direct grain subsidy policy. China should adjust and optimize the direct grain subsidy structure as soon as possible, and strive to improve the efficiency of rice subsidy, to promote transformation of agricultural growth mode, and really guarantee the national grain security.

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