Empirical Analysis of China's Direct Food Subsidy Policy Based on DEA Model：A Case Study of Direct Food Subsidy Policy in Shandong Province

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Abstract   The direct food subsidy is an important agricultural subsidy policy under current conditions，more efficient than grain price protection policy and other policies，and it is of great importance to the agricultural development，but this policy will not meet the interests of society in the long run． In this paper，we make an empirical study with the direct food subsidy policy in Shandong Province as an example，focusing on the analysis of the efficiency of policy implementation in different regions． Study suggests that direct food subsidy has made some achievements，but there are some problems in practice，such as low standard for direct food subsidy policy，less subsidy varieties，generally low efficiency of direct food subsidy policy，lack of unified policy implementation，serious waste of money and inefficient supervision during the subsidy policy implementation process． In order to improve the efficiency of direct food subsidy，it is necessary to raise standard for subsidy，and expand the scope of subsidy varieties；unify the policy，and make the policy suit local circumstances；improve the subsidy mechanism，regulate government behavior，and strengthen supervision．

Key words   Direct food subsidy，DEA（Data Envelopment Analysis），Policy efficiency

1   Introduction

Issues concerning agriculture，countryside and farmers are still the major factors restricting China's economic development at present，and the core of issues concerning agriculture，countryside and farmers is farmers． Farmers' income problems should be solved first in order to solve issues related to farmers． Food production，as one of the main sources of income of the farmers，plays an extremely important role in addressing the issues concerning income of the farmers． "Eleventh Five-Year Plan" clearly put forward doing everything possible to increase farmers' income，and continuing to improve the system of agricultural subsidies to protect farmers' interests．

Since 2006，the global food prices have risen sharply，causing global concern． As of 2008，the global wheat prices and food prices increased by 181% and 83%，respectively． Currently，the world rice prices have reached the highest point in 19 years，and wheat prices have hit a record high in 29 years． The food crisis triggered by the rising food prices is likely to significantly damage the economic development and social security for all countries． The situation is not good，and it will be eventually evolved into a new global crisis． The secretary of the Ministry of Agriculture Sun Zhengcai（2008）believes that as for the current food crisis，the rise in food prices this time is not a short-term phenomenon，the food will bid farewell to the cheap era，and the rise in food prices will have a profound impact on the future development of world ag-

riculture． The food crisis also has some impact on China and sounds the alarm to China's food production and security．

In recent years，especially since the implementation of some preferential agricultural policies such as direct food subsidy and fine seed subsidy in 2003 and 2004，China's food production has increased year by year，basically realizing China's grain self-sufficiency． Despite the rapid agricultural development，the issue of food security can not be ignored． Due to the southern snowstorm in 2008 and northern drought in 2009，China's food prices have risen dramatically，and the agricultural production situation is still grim． The rise in food prices is also one of the main reasons for record-high CPI in China currently． Because of China's huge population base and large demand for food，the food crisis will have a huge impact on China and directly affect China's economic and social development．

At the new stage，China has increased a variety of agricultural subsidies in order to increase food production，protect farmers' interests and maintain national food security． Due to differences in regional economic development，the implementation of specific policies is not the same，and the efficiency of policy implementation varies． Ma Yanli and Yang Yun（2005）take Hebei Province for example to study the influence of China's direct food subsidy policy implemented in 2004 on farmers' willingness to grow grain，farmers' income and production inputs，and the results show that due to the way，processes of subsidies，and other reasons，the direct food subsidy policy makes a small contribution to the rise in farmers' income and the effect of policy implementation is not good．

The effective implementation of agricultural policy will be directly related to China's agricultural problems，and related to people's livelihood． Based on this，in order to better promote the

implementation efficiency of the agricultural policy and thus achieve the agricultural policy objectives, this article regards the direct food subsidy policy in Shandong Province as the object of study, to use DEA method for the efficiency analysis of this policy, and propose feasible suggestions for improving the current direct food subsidy policy based on the model results.

2   Literature review

For the agricultural subsidy policy, the domestic and foreign scholars' views are mainly divided into the following two.

2.1   The agricultural subsidy policy is conducive to the agricultural development and plays a positive role in increasing farmers' income and food production   A. C. Pigou maintains that the subsidies and taxes are the most effective incentives or restrictions, and since the agricultural research and development funding has its special externalities, the improved seed subsidy policy can effectively promote the effective supply of agricultural scientific and technological achievements. J. M. Keynes believes that due to the market failures, the resources would not be optimally allocated to the producers and consumers, so it requires the government's intervention in the economy, and the agricultural subsidy policy is one of them. The optimal supply theory of public goods thinks that the government's responsibility to provide public goods requires the provision of capital subsidies to all aspects of agricultural production.

Kym Anderson and Yujiro Hagami (1985) believe that as the economy continues to develop, the shift from agricultural taxes to agricultural subsidies is a common phenomenon in the process of modern economic and social development, and the agricultural subsidies will be increasingly promoted. Yang Youxiao, Luo Anjun *et al.* (2006) think that due to the two sides of direct food subsidy policy, it plays a role in narrowing the income gap between urban and rural areas. Han Xiping *et al.* (2007) perform the dynamic analysis, and draw the conclusion that in the case of same costs, the direct food subsidy policy is more effective than the production material subsidy policy in increasing the food production. Shen Shuxia and Tong Daxin (2008) believe that the direct food subsidy policy plays a positive role in increasing farmers' income, food supply and promoting the reform of state-owned grain enterprises.

2.2   The agricultural subsidy policy may distort market prices and change the consumption curve, showing the " yellow box" feature, which is an unfair competition in international trade   The neoclassicism maintains that the agricultural subsidy policy would distort market prices, and provide incorrect price information, which will mislead the producers and consumers, thus having an adverse impact on the healthy development of the market. The trade protectionism thinks that the agricultural subsidies would worsen the trading conditions of developing countries, and hamper the upgrading of the industrial structure of developing countries. Due to low income elasticity of demand of agricultural products, the agricultural subsidy policy would put the

country's agriculture at a disadvantage in international trade. Bstoeck (1981) considers that implementing the policy of agricultural subsidies would distort agricultural trade, and proposes that the agricultural subsidies should be eliminated in order to carry out free trade competition.

Through the measurement, Li Peng and Tan Xiangyong (2006) conclude that the policy of direct subsidies plays a certain role in increasing the farmers' net income from growing grain, but because of the low level of subsidy, this role is not large. Through the survey, the research group of Empirical Research of Policy Implementation Effect of Subsidies to Grain Growers and the Policy Recommendations (2007) analyzes the implementation efficiency of agricultural subsidy policy in Jiangxi Province from production growth, income increase, guidance and political effects, and holds that the direct food subsidy policy exhibits some defects such as little economic impact, many operational links and difficulties in verifying the area. Xiao Guoan (2011) performs the demand-supply theoretical analysis based on the welfare economics to research the direct food subsidy policy, and believes that after the implementation of direct food subsidy policy, the food producers will get more benefit than the food consumers, deviating from the original intention of the policy.

3   Theoretical basis of direct food subsidy policy

3.1   Rationality of direct food subsidy policy   (ⅰ) It makes up for the shortcomings of state monopoly grain purchasing and selling policy. The state monopoly grain purchasing and selling policy is essentially to give consumers real subsidies, with low efficiency.

As shown in Fig. 3 – 1, the real subsidies only make the consumer utility function move in U1, while the cash subsidies can make the consumer utility function move in U2. Apparently U2 > U1, and the direct food subsidy policy increases the consumer utility, that is, the cash subsidies are better than real subsidies.
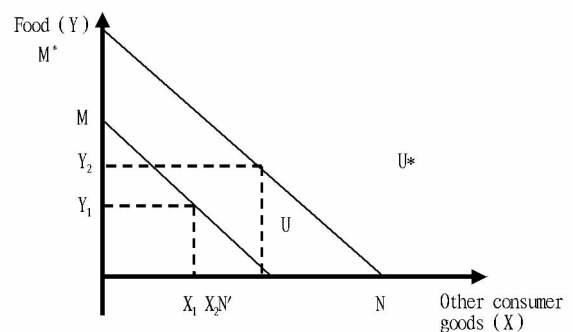
Fig. 1   The difference between real subsidies and cash subsidies

(ⅱ) The direct food subsidy policy under China's current conditions meets Kaldor advance. Assuming in a perfectly competitive market, the food prices are determined by market. As shown in the figure, S and D are the supply and demand curves of food market, respectively; P_0 and Q_0 are the equilibrium price and yield of food market, respectively. After offering the subsidies to

grain farmers, their enthusiasm for growing grain is improved, and the food supply is increased. In the figure, the food supply curve shifts to the right, namely from S to S_1, then the equilibrium yield is Q_1, and the equilibrium price decreases to P1.

When the market price of food drops from P_0 to P_1, the total surplus increase is $B + C + D$. Before the direct subsidies, the producers carry out the transaction at price P_0, and the surplus of producers is $A + B$. When the sales increase to Q_1, and the prices decrease to P_1, the surplus of producers is $A + F$, then the surplus change of producers is $F - B$. At the same time, the government gives subsidy S to farmers, and we can see if $F - B + S > 0$, the surplus of producers will increase, then the grain farmers benefit from this direct subsidy policy. In terms of the total social welfare, it is $A + B + E$ before the direct subsidies, and after the direct subsidies, considering the cost of government subsidies (S), the total social welfare becomes $A + B + C + D + E + F - S$.

From the above analysis, it shows that after the implementation of direct subsidies to grain farmers, the total amount of change in social welfare is $C + D + F - S$, and if $C + D + F > S$, the social welfare is positive, otherwise it is negative. Clearly, the current direct food subsidy policy in China meets the Pareto improvement. It should be noted that after the direct subsidies, the consumers and farmers get benefit at the same time, and only the government loses the subsidy cost. The majority of people get benefit while a few people suffer losses, in line with Kaldor advance.
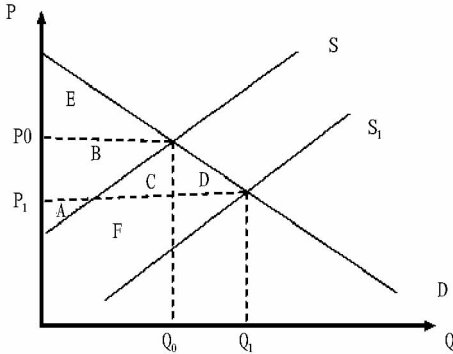

Fig. 2   The impact of food subsidy policy on welfare

(iii) The direct food subsidy policy mobilizes the enthusiasm of farmers for growing grain, which can control the short-term production behavior of farmers, and lay the foundation for the short-term government macro-control.

3.2   Irrationality of direct food subsidy policy
The current direct food subsidy policy is simple, and in the long term, it does not meet the goal of government and farmers, that is, the goal of government to use the direct subsidies to increase the income of farmers deviates from the reality.

(i) When there is no subsidy (with yield per unit as example), the following model can be built:

$$D = a - \beta P \ ; S = \gamma P$$

From $D = S$, we can get:

$$P_0 * = a / (\beta + \gamma)$$
$$Q_0 * = a r / (\beta + \gamma).$$

(ii) Assuming the government gives Δp units of subsidies to yield per unit area, similarly we can get:

$$P_1 * = (a - \gamma P) / (\beta + \gamma)$$
$$Q_1 * = (\gamma(a + \beta \Delta p)) / (\beta + \gamma).$$

Assuming the unit cost of farmers is fixed and it is C, then the farmers' profit function is as follows:

$$\Pi = \frac{\alpha^2 \gamma + (\alpha\beta\gamma - \alpha\gamma^2)\Delta p - \beta\gamma^2(\Delta p)^2}{(\beta + \gamma)} - \frac{C\gamma(\alpha + \beta\Delta p)}{\beta + \gamma}.$$

(iii) Assuming the purpose of government's implementation of subsidies is to increase farmers' income, the government does not care about Δp, and the government and farmers' objective function is consistent.

Let $f(\Delta p) = \Pi$, then $\max\Pi = \max[f(\Delta p)]$.

Let $f'(\Delta p) = 0$, then $\Delta p = \dfrac{\alpha\gamma(\beta - \gamma) - C\beta(\beta + \gamma)}{2\beta\gamma^2}$.

(iv) It is assumed here that the price elasticity of demand for agricultural products is less than the price elasticity of supply, then $\left|\dfrac{dD}{dp}\right|\left|\dfrac{P}{D}\right| < \left|\dfrac{dS}{dp}\right|\left|\dfrac{p}{S}\right|$ and $\beta\dfrac{P}{D} < \gamma\dfrac{p}{S}$.

From $D = S$, we solve $\beta\gamma$ and bring it into Δp to get Δp_0.

This can be explained as the fact that in order to improve the income of farmers, the government must reduce the current subsidies to negative subsidies, which indicates that the government's direct subsidies are contradictory to grain farmers' profit maximization, and the implementation of the policy is unreasonable. Conspicuously, the direct food subsidy policy can increase the utility of farmers and grain consumers, stimulate the grain growing behavior of farmers and strengthen the government's macro-control in the short run, but this policy does not meet the interests of the government and the farmers in the long run, and it is not well implemented.
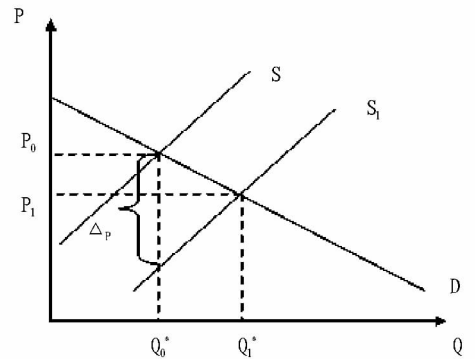
Fig. 3   Unit production subsidies

4   Empirical analysis

This paper uses data envelopment analysis (DEA) to measure the implementation effect of direct food subsidy policy, and takes the financial investment of direct food subsidy and policy objectives as the object of study to assess the direct food subsidy policy from "system efficiency" and "scale efficiency". "System efficiency" means whether the existing financial investment effectively promotes the achievement of policy objectives, and "scale efficiency" means whether the subsidy input scale is effective, and whether it

is in the best condition of constant returns to scale under the premise of the established direct food subsidy system.

4.1 DEA model and C2R model   Data envelopment analysis (DEA), developed by Charnes, Cooper & Rhodes (1978), is a nonparametric method in operations research and economics for the estimation of production frontiers. It is used to empirically measure productive efficiency of decision-making units (or DMUs). Although DEA has a strong link to production theory in economics, the tool is also used for benchmarking in operations management, where a set of measures is selected to benchmark the performance of manufacturing and service operations. In the circumstance of benchmarking, the efficient DMUs, as defined by DEA, may not necessarily form a "production frontier", but rather lead to a "best-practice frontier" (Cook, Tone and Zhu, 2014). DEA is referred to as "balanced benchmarking" by Sherman and Zhu (2013). DEA model does not focus on the specific operation within the system, and this model also has a strong economic background, so using DEA to analyze the implementation effect of China's direct food subsidy policy is of strong operability.

In this paper, we use the basic DEA model C^2R. Assuming there are n decision-making units (DMU_j, n), and each decision-making unit has m kinds of input and s kinds of output, as shown in Table 4−1. In the table, x_{ij} is the input of input i of DMU_j; y_{kj} is the output of input k of DMU_j; v_i is the measurement of input i; u_k is the measurement of input k ($j = 1, 2, \cdots, n$; $i = 1, 2, \cdots, m$; $k = 1, 2, \cdots, s$; $x_{ij} > 0$, $y_{kj} > 0$, $j = 1, 2, \cdots, n$).

For this model, the smaller the better for the input and the greater the better for the output. Of course, there is a need to take into account the marginal effect of input during the input process.

From the calculation formula of C^2R model, the C2R model of the k_0-th DMU is obtained as follows:

$$\text{MAX } V_p = \mu^T \cdot Y_0.$$
$$s.t. \begin{cases} W^T \cdot X_k - \mu^T \cdot Y_k \geqslant 0, (k = 1,2,\ldots,n) \\ W^T \cdot X_0 = 1 \\ W, \mu \geqslant 0 \end{cases}$$

In the matrix, $t = 1(V^T \cdot x_0)$, $t \cdot V = W$, $t \cdot U = \mu$, and k_0 efficiency index is simplified as k efficiency index.

The surplus variable and slack variable S − and S + are introduced, and the model is as follows:

$$\text{MIN } V_D = \theta.$$
$$s.t. \begin{cases} \Sigma_{k=1}^{K} X_k \cdot \lambda_k + s^- = \theta \cdot X_0 \\ \Sigma_{k=1}^{n} Y_k \cdot \lambda_k - s^+ = Y_0 \\ \lambda_k \geqslant, \ k = 1, 2, \cdots, n; \ s^+, s^- \geqslant 0 \end{cases}$$

This matrix is the dual matrix of the original matrix, and θ is the valid value of the decision-making unit $DMUk_0$, namely the system efficiency index; λ is the combination proportion of k $DMUs$ in a combination of DMU reconstructed by the decision-making unit.

In the model, if the optimal solution of linear programming (P) meets the condition $V_P = \mu_0^T \cdot Y_0 = 1$, then the decision-making unit k_0 is of weak DEA efficiency; if the optimal solution of linear programming (P) meets the condition $V_P = \mu_0^T \cdot Y_0 = 1$, and $\omega_0 > 0$, $\mu_0 > 0$, then the decision-making unit k_0 is of DEA efficiency. The theorem can be summarized for the judgment of θ, and let $r = \theta$, then r is the scale efficiency index of DMU_{k0}. If $k = 1$, the scale merit of DMU is constant; if $k < 1$, the scale merit of DMU is increasing; if $k > 1$, it means that the scale merit of DMU is decreasing.

Table 4−1   DEA input-output data

		DMU$_1$	DMU$_2$	...	DMU$_n$		
V_1	1→	X_{11}	X_{12}	...	X_{1n}		
V_2	2→	X_{21}	X_{22}	...	X_{2n}		
		□	□	...	□		
V_m	m→	X_{m1}	X_{m2}	...	X_{mn}		
		Y_{11}	Y_{12}	...	Y_{1n}	1	U_1
		Y_{21}	Y_{22}	...	Y_{2n}	2	U_2
		□	□	...	□		
		Y_{s1}	Y_{s2}	...	Y_{sn}	S	U_s

Table 4−2   The direct subsidies in the prefecture-level cities of Shandong Province in 2011   Unit: 10^4 yuan/mu

Regions	The sum of subsidy	Subsidy standards (food)	Subsidy standards (agricultural materials)	Subsidy varieties	Subsidy range
Heze	8 100	14	65.2	Wheat	Growers + large scale growers
Dezhou	62 771	14	50	Wheat	Growers + large scale growers
Zaozhuang	30 900	14	72.78	Wheat	Growers
Tai'an	36 300	14	65.2	Wheat	Growers
Weifang	28 350	14	65.2	Wheat	Growers
Zibo	32 700	14	62.78	Wheat	Growers + large scale growers
Jining	5 048.5	14	65.2	Wheat	Growers
Jinan	41 000	14	65.2	Wheat	Growers + large scale growers
Linyi	45 000	14	65.2	Wheat	Growers
Rizhao	21 874	14	50	Wheat	Growers
Liaocheng	9 188.06	14	30.5	Wheat	Growers + large scale growers
Binzhou	9 337	14	65.2	Wheat	Growers
Qingdao	43 800	16	66.2	Wheat	Growers
Dongying	5 970.96	15	71.18	Wheat	Growers
Yantai	28 000	15	64.2	Wheat	Growers
Weihai	10 954	15	64.2	Wheat	Growers
Laiwu	4 822.5	15	49	Wheat	Growers

4.2 Data selection

4.2.1 DMU selection. In this study, we take the direct food subsidy policy of Shandong Province in 2011 as the research object. This policy is evenly implemented in Shandong Province, which can better reduce the error in the study. *DMUs* are the 17 prefecture-level cities in Shandong Province.

4.2.2 Indicator selection. Input indicators should reflect the financial investment degree and standards. For subsidy standards, the direct food subsidy policy in Shandong Province is mainly to give subsidies according to the growing area, and the unit is yuan/mu. Given that the direct agricultural material subsidy is put forth based on the direct food subsidy and it is often given combined with direct food subsidy, they are collectively referred to as the comprehensive direct food subsidy and the direct agricultural material subsidy will be used as input.

$$\mathrm{MIN}\begin{cases} 6\ 100\lambda_1 + 52\ 771\lambda_2 + 20\ 900\lambda_3 + 26\ 300\lambda_4 + \cdots + 8\ 954\lambda_{16} + 1\ 822.5\lambda_{17} + S_1^- = 6\ 100\theta \\ 14\lambda_1 + 14\lambda_2 + 14\lambda_3 + 14\lambda_4 + \cdots + 15\lambda_{15} + 15\lambda_{16} + 17\lambda_{17} + S_2^- = 14\theta \\ 65.2\lambda_1 + 50\lambda_2 + 72.78\lambda_3 + 65.2\lambda_4 + \cdots + 64.2\lambda_{16} + 49\lambda_{17} + S_3^- = 65.2\theta \\ 3\ 426\ 971\lambda_1 + 2\ 874\ 696\lambda_2 + 932\ 858\lambda_3 + \cdots + 441\ 868\lambda_{16} + 81\ 571\lambda17 - S_1^+ = 3\ 426\ 971 \\ 2\ 580.75\lambda_1 + 3\ 194.8\lambda_2 + 294\ 434\lambda_3 + \cdots + 3\ 688.75\lambda_{16} + 3\ 855.59\lambda17 - S_2^+ = 2\ 580.75 \\ \lambda_1,\ \lambda_2,\ \lambda_3,\ \cdots,\ \lambda_{16},\ \lambda_{17} \geq 0;\ S^+,\ S^- \geq 0 \end{cases}$$

Similarly, we can obtain the dual programming model of other prefecture-level cities. The DEAP 2.0 software is used for data analysis, with input as orientation, and the results are as follows.

Table 4–3 DEA evaluation results of efficiency of direct food subsidy

Regions	System efficiency	Scale efficiency	Conclusions
Heze	1.000	1.000	Efficient
Dezhou	1.000	1.000	Efficient
Zaozhuang	0.778	0.778	Inefficient
Tai'an	0.747	0.747	Inefficient
Weifang	0.903	0.903	Inefficient
Zibo	0.743	0.743	Inefficient
Jining	1.000	1.000	Efficient
Jinan	0.873	0.873	Inefficient
Linyi	0.865	0.865	Inefficient
Rizhao	0.899	0.899	Inefficient
Liaocheng	1.000	1.000	Efficient
Binzhou	0.922	0.922	Inefficient
Qingdao	1.000	1.000	Efficient
Dongying	1.000	1.000	Efficient
Yantai	0.997	0.997	Inefficient
Weihai	0.910	0.943	Inefficient
Laiwu	1.000	1.000	Efficient

4.3.1 System efficiency analysis. The system efficiency measures whether the existing financial investment effectively contributes to promoting the realization of policy objectives. Table 4–3 and Table 4–4 show that the direct food subsidy is efficient in 7 prefecture-level cities of Shandong Province ($\theta = 1$) while the direct food subsidy is inefficient in other cities. In terms of the difference in subsidy between regions, the average system efficiency of direct food subsidy in various cities is 0.92, and the absolute value of skewness is slightly larger than the standard deviation. On

The direct food subsidy and direct agricultural material subsidy in Shandong Province take the growing area of wheat as a reference, so the input indicators include the total sum of comprehensive direct food subsidy, direct food subsidy per unit area of wheat and direct agricultural material subsidy per unit area. For the output indicator, the goal of direct food subsidy policy to increase food production and increase farmers' income is regarded as the output. Data sources, as shown in Table 4–2, are mainly from *Shandong Statistical Yearbook* (2012), Statistical Yearbook of some prefecture-level cities in Shandong Province and Bureau of Statistics and Financial Bureau of the prefecture-level cities.

4.3 Data analysis Using the DEA method, we can get the programming model for policy efficiency assessment of 17 prefecture-level cities in Shandong Province. Taking Heze City for example, we establish the following dual programming model:

the whole, the difference is not obvious, mainly because during the promotion of direct food subsidy in Shandong Province, the policy is implemented stringently in each city. However, because of differences in economic differences or policy implementation, this policy exhibits different performance in various regions.

In addition, from DEA evaluation results, the inefficiency areas of direct food subsidy are concentrated in the major agricultural cities in the west of Shandong Province, such as Linyi City, Zaozhuang City and Tai'an City, as well as the several coastal industrial cities in the east of Shandong Province, such as Weihai, Binzhou, Rizhao and Weifang. Studies suggest that in several large western agricultural cities of Shandong Province, the farming area is large, and the subsidized area and population is large, but there may be differences in the subsidy standards and ways, it is prone to inefficiency. In several coastal cities in eastern Shandong Province, the industry and commerce are developed, and the proportion of primary industry output value is not high, so in the course of the implementation of agricultural subsidies, it is prone to lack of deep understanding of the policies, and the policy is also prone to inefficiency. Of course, the subsidy policy of eastern cities is significantly more efficient than that of western major agricultural cities, and the eastern cities focus on improving the agricultural competitiveness through the market and technology.

4.3.2 Scale efficiency analysis. Scale efficiency is used to analyze whether the scale of policy input is reasonable under the given conditions. From the above evaluation results, it can be found that the direct food subsidy in the prefecture-level cities of Shandong Province is generally at the stage of increasing return to scale (scale efficiency < 1), that is, currently, it is necessary to increase direct food subsidy to improve the efficiency of subsidy policy.

At the same time, it can be found that on the input-oriented basis, the system efficiency shows that some inefficient subsidies exist in 10 prefecture-level cities of Shandong Province, while the scale efficiency shows that the majority of food subsidies in Shandong Province is at the stage of increasing return to scale, and it is necessary to increase subsidies. The two kinds of efficiency indicate that there is a waste of direct food subsidy in some regions of Shandong Province, and some subsidies are not channeled into agriculture, so there is a need to increase the subsidy supervision.

5 Conclusions and recommendations

5.1 Conclusions

5.1.1   The direct food subsidy policy is of important significance to China's food production. By theoretical analysis, studies suggest that the direct food subsidy policy has mobilized the enthusiasm of farmers, and has a positive impact on the farmers' income, food production and current development of China's agriculture. At least in the short term, it exhibits Kaldor advance and the promotion of this policy is in line with current social interests.

5.1.2   The direct food subsidy policy does not meet the needs of social development in the long term. The direct food subsidy policy essentially shows a kind of price support, which is not consistent with current agricultural policies related to the WTO. Besides, we can draw the conclusion from the theoretical model that under long – term conditions, the direct food subsidy policy is against the goal of government and farmers, leading to losses of farmers and government.

5.1.3   There is too much inefficiency in direct food subsidy policy during the implementation. From the "system efficiency" and "scale efficiency", we carry out the efficiency evaluation of direct food subsidy, and the results show that the efficiency of direct food subsidy in Shandong Province is generally not high, and there is a difference in the efficiency of direct food subsidy between the cities. The inefficiency areas of direct food subsidy are concentrated in the major agricultural cities in the west of Shandong Province, as well as the several coastal industrial cities in the east of Shandong Province.

5.1.4   There are low standards for direct food subsidy policy and less subsidy varieties. Through the DEA analysis of direct food subsidy in Shandong Province, the inefficiency areas of direct food subsidy mostly show increasing returns to scale, and inadequate sum of subsidy and subsidy standards. In addition, the subsidy variety is rare, and the subsidized crop in Shandong Province is only wheat, which is difficult to raise farmers' enthusiasm for planting.

5.1.5   There are shortcomings in the fund supervision during the subsidizing. Studies suggest that in the process of implementing direct food subsidy in Shandong Province, there is a serious waste of subsidies in some cities, and the direct food subsidies do not entirely benefit farmers. There are shortcomings in the supervision, and the farmers' interests are damaged due to cumbersome procedures of subsidy or other human factors, and the subsidies do not really benefit farmers.

5.2 Recommendations

5.2.1   Adhering to implementing the direct food subsidy policy under the current conditions. Under current conditions, China should continue to intensify efforts to promote agricultural subsidies, ensure the smooth implementation of the policy, and promptly solve the problems in the policy to enhance the effect of the implementation of the policy. Meanwhile, it is necessary to make full use of the support policies of WTO for developing countries, and implement the agricultural subsidy policy within 8.5% of the available space. In the long term, the development of China's agriculture should have the support of technology and education to adapt to the international rules, and improve its competitiveness.

5.2.2   Expanding the scope of direct food subsidy and improving the standard of direct food subsidy. Taking Shandong Province for example, to mobilize the higher enthusiasm of farmers, it is necessary to take into account the production of other crops, and avoid the subsidy merely for food crops. Fruit and sugar crops also need to be incorporated into the scope of subsidy so as to ensure balanced development of agriculture. At the same time, it is necessary to improve the sum of direct food subsidy and direct food subsidy standards. The inefficiency areas of direct food subsidy in Shandong Province are generally at the stage of increasing returns to scale, so improving the sum of direct food subsidy and direct food subsidy standards can help to significantly alter the policy efficiency and have an important impact on farmers' income and food production.

5.2.3   Implementing the direct food subsidy policy according to the actual local situation. Taking Shandong Province for example, there are large differences in the economic environment between the east and west of Shandong Province, and the implementation of direct food subsidy policy is also not the same. In the western cities of Shandong Province, it is necessary to pay more attention to how the direct food subsidy policy is smoothly implemented, whether the sum and ways of subsidy are reasonable and effective, and whether the agricultural development policy objectives are achieved. In the developed eastern industrial and commercial areas, it is necessary to safeguard farmers' interests, and consider how to improve the international competitiveness of agriculture in compliance with international rules.

5.2.4   Simplifying the direct food subsidy links and increasing the supervision on the implementation of direct food subsidy policy. The smooth and effective implementation of the food subsidy policies is related to people's livelihood, so in the course of direct subsidy, it is necessary to simplify the subsidy process and directly give the direct food subsidy to farmers in full sum so as to reduce the transaction costs. At the same time, it is necessary to increase the supervision on direct food subsidy policy to regulate the implementation process of direct food subsidy policy and prevent the flaws in the implementation of direct food subsidy policy to make the agricultural policy truly benefit farmers and agriculture.

operation among the subjects on the chain.

3.4 Strengthening the training of professional talent of cold chain logistics of agricultural products   The lack of cold chain logistics talents has largely restricted the development of cold chain logistics, but the lack of talent also indicates more job opportunities. If this issue can be resolved properly, it will not only promote the development of cold chain logistics of agricultural products, but also provide more employment opportunities and broader stage for more job seekers.

4   Conclusions

In short, since the emergence of the concept of cold chain, the experts and scholars' studies have come along, and especially in recent years, with changes in the market environment, there have been more and more a variety of theoretical studies and practical attempts carried out around "cold chain logistics of agricultural products". The cold chain logistics of agricultural products ushers in great opportunities for its development, but opportunities and challenges will always coexist for the subjects in the cold chain market. This paper reviews the experts and scholars' studies on cold chain logistics of agricultural products in recent years, in order to provide some reference for resolving the related issues.

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