Research Article
Research on the Influence Factors on the Crop Food Supply Price using Data Envelopment Analysis Method

Wang Yan
Wenjing College, Yantai University, Yantai 264005, China

Abstract: The study aims to investigate the influence factors on the crop food supply price using the Data Envelopment Analysis (DEA) method. Crops are the basic food rations for urban and rural residents and occupy the most important position in the food consumption. The price of the crop food has important influence on the stable economic operation and even social stability in China; hence it is crucial to find out the fluctuation rules and formation mechanism of crop food supply price. However, there is very little work has been done to look into the relationship between different influence factors and the crop food supply price. As a result, this study proposes a new method based on the DEA to quantitatively investigate the influence factors on the crop food supply price. The inflation, seeded area, cost of production, yield per unit area and rice consumption level have been selected as the influence factors in this study. Empirical analysis using the historical data acquired from China Statistical Yearbook during 2005 to 2012 has been carried out to calculate the quantities of the five factors connected to the crop food price change. The analysis results show that the price of the crop food is influenced obviously by the yield per unit area; meanwhile the cost of production has a certain impact on the crop food price. Hence, useful solutions can be proposed to stabilize the crop food price.

Keywords: Crop food price, data envelopment analysis, influence factors

INTRODUCTION

Food price is playing a more and more important role on the resources allocation of grain production in China. The food price affects the income of the peasant household and determines the domestic food supply; therefore, stable food price guarantees the food security, farmers' income and even the whole smooth running of the food economy in our country. Since the economy reform in China the inflation is accompanied by the jump of the food price. This phenomenon makes food prices unstable, attracting much attention to investigate the fluctuation rules and formation mechanism of food supply price.

Changes in food price are subject to many factors. Any items that affect food supply, food demand or food circulation can cause changes in food prices. Li and Zhu (2011) have analyzed the overall characteristic and regional difference of China's grain price fluctuations. The importance of the macroeconomic regulation and control has been discussed for the food price. Tan and Luo (2009) found that there is one-way granger causality between the food prices and inflation. They pointed out that the short-term inflation has a strong influence on the food prices, but in the long term this effect could be ignored. Li (2011) has investigated the influence of the CPI on the food price. Luo and Liu (2010) has analyzed the asymmetry characteristics of

the grain price fluctuations and put forward correlated prediction model to forecast the food price movements to improve the grain market and guide the market to participate rational investment. Sun and Meng (2010) has discussed the main influence factors of China's grain price fluctuations and built a model based on Support Vector Machine (SVM) for food prices prediction. However, there is very little work has been done to look into the relationship between different influence factors and the crop food supply price. How to quantitatively describe the relationship of the influence factors on the crop food supply price is still a problem and challenge in the field. Hence, it is crucial to investigate the influence factors on the crop food supply price to guide and regulate the food market.

This study aims to quantitatively investigate the relationship between different influence factors to the crop food supply price. The influence factors include the inflation, seeded area, cost of production, yield per unit area and rice consumption level. A new method based on the DEA is proposed to calculate the degrees of influence of these factors on the price of the crop food. Empirical analysis using the historical data acquired from China Statistical Yearbook during 2005 to 2012 has been carried out. The calculation results indicate useful information for solutions to the stabilization of the crop food price.

MATERIALS AND METHODS

Data Envelopment Analysis (DEA) adopts statistical analysis to access relationship of an input-output pair (Han and Ma, 2013). DEA is powerful to quantitatively describe relationship of single/multi-input and single/output pair (Jahanshahloo *et al.*, 2011). DEA is able to evaluate the efficiency of the input-output pair using the efficient frontier even with unknown information about the inputs and outputs (Igan and Pinheiro, 2010). This feature is very suitable for the investigation of the relationship between different influence factors and the crop food supply price. In this study, we use the DEA model with constant scale of production (Charnes *et al.*, 1978) to calculate the values of influence factors to the crop food price. In the DEA model, its inputs are the selected five factors F_i ($i = 1, 2, …, 5$) and its outputs are the influence values I_i ($i = 1, 2, …, 5$). Then, the relationship between different influence factors and the crop food supply price can be modeled as:

$$Q = \frac{\alpha^{\mathrm{T}} I}{\beta^{\mathrm{T}} F} \qquad (1)$$

where, α and β are the weighting values connecting the inputs and outputs. To characterize the influence degree of the inputs, the weighting values should meet the following constrain:

$$\max(Q) = \lambda \qquad (2)$$

where, λ subjects to:

$$\begin{cases} \lambda = \dfrac{\alpha^{\mathrm{T}} I_i}{\beta^{\mathrm{T}} F_i} \le 1, (i = 1, 2, ..., 5) \\ \alpha \ge 0, \beta \ge 0 \end{cases} \qquad (3)$$

Table 1: The test result of the collinearity diagnosis

Variables	Co-linearity diagnosis	
	Tolerance	Variance Inflation Factor (VIF)
Inflation	0.377	5.368
Seeded area	0.461	4.852
Cost of production	0.811	2.743
Yield per unit area	0.205	6.152
Rice consumption level	0.315	3.657

RESULTS AND DISCUSSION

Factors influencing the crop food price are extremely complex. Based on the related theory of western economics, it mainly depends on supply and demand. Although the crop food price in China is set by the government, it ultimately determined by the supply and demand. As a result, this study chooses the inflation, seeded area, cost of production, yield per unit area and rice consumption level as the influence factors. Empirical analysis using the historical data acquired from China Statistical Yearbook during 2005 to 2012 has been carried out to calculate the quantities of the five factors connected to the crop food price change.

First of all, to standardize the raw data, the missing data was replaced by the mean value of the sequence. Then the co-linearity diagnosis was carried out to test the correlation coefficient matrix R of the sequence. Table 1 lists the test result, which suggests that there is no strong co-linearity between the input variables.

To quantitatively investigate the relationship between different influence factors and the crop food supply price, the DEA with constant scale of production has been employed in this study. The input analysis and output analysis have been carried out to quantitatively describe the relationship between different influence factors and the crop food supply price. The analysis results are shown in Fig. 1 and 2.
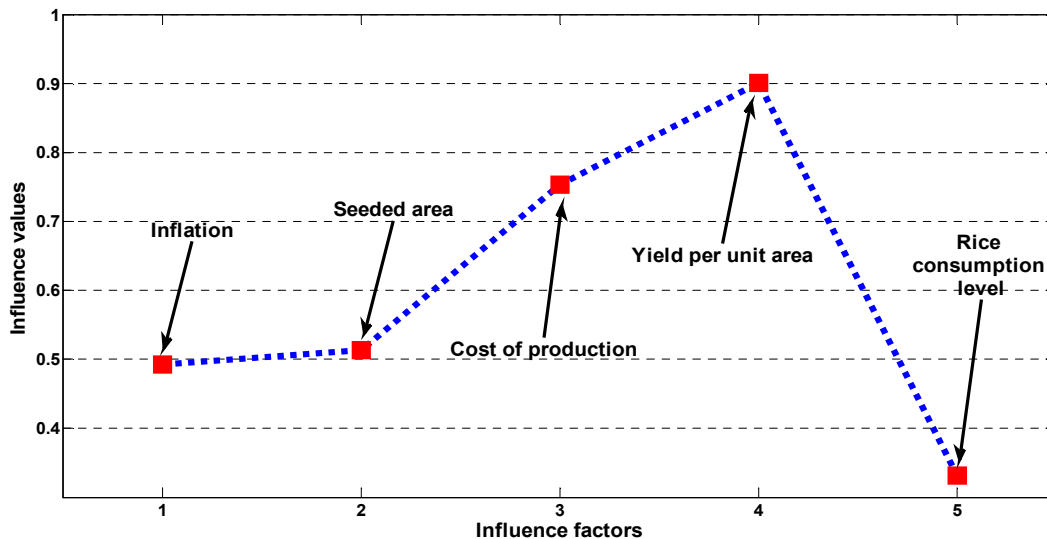

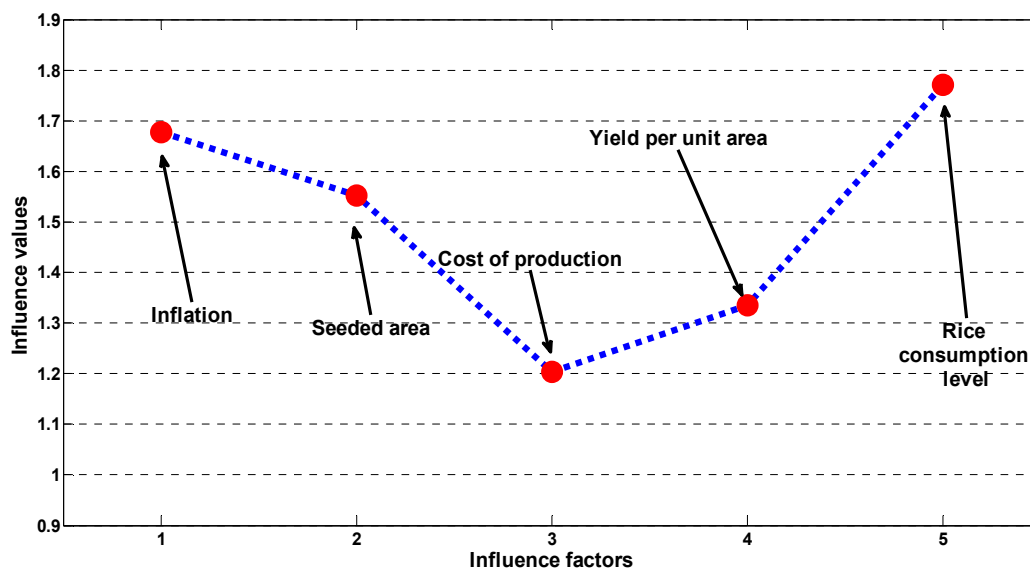Fig. 1: Input analysis: quantity of the influence factors to the crop food price

Fig. 2: Output analysis: quantity of the influence factors to the crop food price

It can be seen from the input analysis shown in Fig. 1 that the influence factor of yield per unit area takes the leading role in the crop food price change. The quantity value of this factor is 0.901, which indicates that the fluctuation of the yield per unit area will bring great change in the crop food price. Hence, it is suggested to maintain and improve the yield per unit area to stabilize the crop food price. It also can be seen from Fig. 1 that the cost of production plays a second role in the crop food price change. To a certain degree, the factor of cost of production influences the crop food price. The other factors of inflation, seeded area and rice consumption level score relative low point in the DEA analysis. As a result, these three factors do not impact the crop food price to a significant level.

It can be seen from the output analysis shown in Fig. 2 that the influence factor of rice consumption level gets the largest value. The quantity value of this factor is 1.771, which indicates that the impact of the rice consumption level is the weakest one against the other four factors on the crop food price change. Hence, it can infer that improving the rice consumption level may be not effective for the stabilization of the crop food price. It also can be seen from Fig. 2 that the yield per unit area scores 1.335 and the cost of production scores 1.204. This means that these two factors influence the crop food price significantly. Hence, comparing Fig. 1 and 2 it can be noticed that the crop food price will be influenced greatly by the factors of yield per unit area and cost of production. In order to keep the crop food price it is reasonable to pay attention to these two factors.

CONCLUSION

The price of the crop food has important influence on the stable economic operation and even social stability in China. In this study the DEA has been adopted to investigate the influence factors of the crop food price. Through empirical analysis using historical data it suggests that the crop food price will be influenced greatly by the factors of yield per unit area and cost of production. Hence, to maintain the crop food price, the government and industry need improve the yield per unit area and decrease the cost of production. It should take advantages of new technology to improve the efficiency of resource utilization. The resource was assigned in different areas and the cost of grain production varies in different areas. Thus, it need reasonably arrange the location of production and determine the processing technique through interregional division of resource conditions. Therefore, correct protection mechanism can guarantee the stabilization of the crop food price.

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