

Research Article

Quantitative Analysis of Influence Factors on Distribution Efficiency of Agricultural Products: A Case Study using Data Envelopment Analysis

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Abstract: This study aims to investigate the influence factors on the distribution efficiency of agricultural products. Distribution efficiency of agricultural product directly reflects the efficiency of agricultural distribution system. The output and cost in the process of agricultural distribution can be accessed by distribution efficiency. Much work has been done to measured distribution efficiency by single indicator but little work has been done to investigate the multiply indicators and their impacts on the distribution efficiency of agricultural products. Hence, for the first time, the Data Envelopment Analysis (DEA) has been used to assess the influence of multiply indicators on the distribution efficiency of agricultural products. A case study using the historical data has been carried out. The empirical analysis results show that the level of informatization and logistics infrastructure greatly influence the distribution efficiency of agricultural products while the Logistics transportation and the professional level of labors do not promote the efficiency of agricultural distribution system. Hence, useful suggestions could be proposed to provide theoretical reference for the construction of robust and efficient agricultural distribution system.

Keywords: Agricultural products, data envelopment analysis, distribution efficiency, influence analysis

INTRODUCTION

After market-oriented reform in the past 30 years, the vast majority of agricultural products in China is established a market-oriented agricultural product distribution system to basically form a nationwide distribution of agricultural products (Kou, 2008). In theory, to perfect the market mechanism it will automatically follow the principle of comparative advantage to arrange production and distribution of agricultural products. But China's agricultural product distribution is still small in size due to short development time. The existence problems hinder the distribution of agricultural products. This requests comprehensive research on China's agricultural products distribution efficiency. Agricultural products distribution efficiency is involving with how to measure the distribution efficiency of agricultural products, what factors affect the distribution of high and low efficiency and how to improve the efficiency of agricultural product distribution (Wu, 2002).

In recent years, the research on the distribution of agricultural products is increasing. Wang (2003) suggested that the neglect of distribution is an important reason for the slow development of agricultural industrialization. Xie (2003) argued that the agricultural development of our country has entered into the stage of saving inputs and improving allocative efficiency. The development in agricultural logistics industry, especially in the reform of grain distribution system,

becomes urgent for the rural institutional change on agricultural modernization. Wang (2009a) pointed out that the contribution rate between agricultural products distribution and agricultural industrialization in China in improves gradually. Modern distribution of agricultural products will improve the agricultural economic benefits and ensure that urban and rural market provide a good supply channels in guiding production, expanding consumption, absorbing employment, raising farmers' income and so forth. Although the distribution of agricultural products is very important for the national economy, very limited work has addressed the problem of the operation quality of China's agricultural product distribution. To measure an important indicator for distribution quality of agricultural products, it is crucial to investigate the efficiency of the rural distribution of agricultural products in China, namely the use of limited resources to obtain the largest distribution capacity of agricultural products. In today's socialist market economy, the distribution decides the production (Wang, 2009b). Therefore, it is imperative to investigate the distribution efficiency of agricultural products in the rural area.

Luo *et al.* (2000) provided a theoretical analysis framework from the perspective of transaction costs for the distribution efficiency of agricultural product. Xu and Xie (2007) argued that the new rural construction should deepen the level of division of labor and specialization to promote rural economic endogenous growth and try to reduce the transaction costs to

increase the distribution efficiency. Kou and Tan (2008) pointed out that the distribution efficiency of agricultural products is the distribution of agricultural products in the process of all kinds of inputs and outputs. However, qualitative analysis has been adopted in existing work; little work has carried out the quantitative analysis on the evaluation of agricultural products distribution efficiency.

In order to quantitatively investigate the influence factors on the distribution efficiency of agricultural products, this study has proposed a new method based on the Data Envelopment Analysis (DEA) in the case analysis. Empirical data has been used to quantitatively evaluate the influence effect of 5 influence factors on the distribution efficiency. These factors include the agricultural products amount, level of informatization and logistics infrastructure, professional level of labors, level of Logistics transportation and capital stock of agricultural products. The impact quantities of the 5 factors have been measured by DEA. Lastly, solutions have been provided for the first time to ensure the stable development of agricultural products.

THE DATA ENVELOPMENT ANALYSIS (DEA)

DEA: DEA (Banker *et al.*, 1984) is a useful and reliable tool to quantitatively investigate the distribution efficiency of agricultural products. The theory of DEA can be briefly described as follows (Jahanshahloo *et al.*, 2011).

Let the inputs are $X = [x_1, x_2, \dots, x_p]$ and the outputs are $Y = [y_1, y_2, \dots, y_q]$, then the efficiency of a Decision Making Unit (DMU) is (Banker *et al.*, 1984):

$$\theta = \frac{\beta^T Y}{\alpha^T X} \quad (1)$$

where, α and β are the weight vectors of the inputs and outputs, respectively. To obtain maximized θ , (1) should subject to:

$$\begin{cases} \max(\theta) = \frac{\beta^T Y}{\alpha^T X} \\ \text{s.t } \frac{\beta^T Y_\gamma}{\alpha^T X_\gamma} \leq 1, (\gamma = 1, 2, \dots, m) \\ \alpha \geq 0, \beta \geq 0 \end{cases} \quad (2)$$

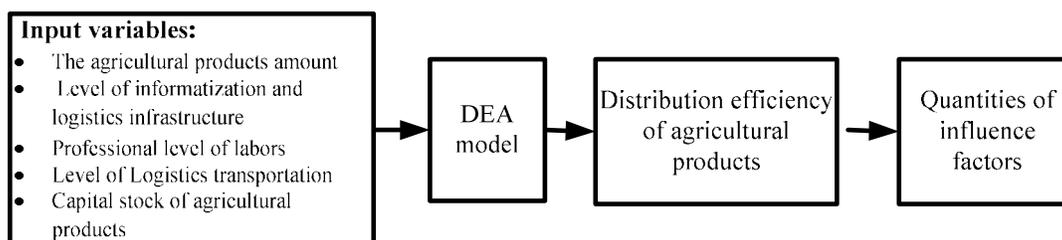


Fig. 1: The diagram block of the proposed DEA model applied to accessing the distribution efficiency of agricultural products

DEA presents the following advantages (Jahanshahloo *et al.*, 2011):

- DEA can process multiple inputs and outputs efficiency calculation
- DEA can process performance evaluation without prior information on the inputs
- DEA can provide objective efficiency calculation

Inputs and output of the DEA model: In the process of agricultural products, the distribution efficiency refers to the ratio between the distribution output and distribution spending. The distribution output of agricultural products is the sum of distribution expenses occurred in the process of distribution of agricultural products. Due to multiply segments in the distribution of agricultural products, it is very difficult to obtain the distribution output and spending. Therefore, it is difficult to use a single index to the distribution efficiency of agricultural products. A group of related evaluation index system is hence used to access the agricultural products distribution efficiency.

In this study we have chosen 5 inputs for the DEA model.

- **The agricultural products amount:** Distribution is the bridge between producers and consumers. Productions can reach to the hands of consumers by the distribution processing. Hence, in the distribution of agricultural products, the agricultural products amount is a very important index to evaluate the distribution efficiency.
- **Level of informatization and logistics infrastructure:** Absolutely, the infrastructure for efficient distribution of agricultural products is the base of production distribution.
- **Professional level of labors:** The labors are the director in the distribution of agricultural products. The professional level of labors determines the distribution efficiency of agricultural products.
- **Level of Logistics transportation:** The transportation efficiency of the agricultural products will influence the distribution efficiency greatly.
- **Capital stock of agricultural products:** The capital stock will influence the whole distribution system.

- The diagram block of the proposed DEA model applied to accessing the distribution efficiency of agricultural products is shown in Fig. 1.

CASE STUDY

Empirical data: In order to investigate the influence factors on the distribution efficiency of agricultural products, the statistical data of 28 provinces and regions in China has been used in the empirical analysis. The empirical data is obtained from China Statistical Yearbook and China Rural Statistical Yearbook during 2005 to 2012. Table 1 lists the statistics of the influence factors.

DEA analysis: The distribution efficiency of agricultural products has been analyzed by DEA to quantitatively investigate the influence factors. Figure 2 and 3 show the analysis results.

It can be seen in the input analysis of DEA in Fig. 2 that the distribution efficiency of the level of informatization and logistics infrastructure is the largest one. This indicates that this factor is the dominant one in the distribution of agricultural products. One can also be noticed that the efficiency of professional level of labors is the second large value. This indicates that the professional level of labors will influence the efficacy of the distribution of agricultural products; however, its influence intensity is much less than the level of informatization and logistics infrastructure. It is surprising when one finds that the Logistics

transportation does not play dominant roles in the distribution of agricultural products.

It can be seen in output analysis in Fig. 3 that the distribution efficiency of the agricultural products amount is the largest one. This indicates that this factor is the least influencing one of the 5 factors in the distribution of agricultural products. In contrast, the factor of the level of informatization and logistics infrastructure scores the smallest value, which indicates that this factor is the dominant one in the distribution of agricultural products. The analysis result in Fig. 3 agrees well with the input analysis results in Fig. 2. The empirical analysis results show that the level of informatization and logistics infrastructure greatly influence the distribution efficiency of agricultural products while the Logistics transportation and the professional level of labors do not promote the efficiency of agricultural distribution system.

Useful suggestions: In order to improve the efficiency of agricultural distribution system, the following solutions can be provided in practice.

- **Increase the budget on the informatization and logistics infrastructure:** Rural informatization and logistics infrastructure has strong positive promoting effect on the agricultural distribution system. The budget in the east regions is 1.78 times to the western regions. As a result, the distribution efficiency in the east regions is better than the western regions. Lack of infrastructure investment becomes the main obstacle to rural economy

Table 1: The statistics of the influence factors

Influence factor	Mean value	S.D.	Minimum	Maximum	Number of observations
Agricultural products amount (million tons)	2113.7	1875.2	6578.2	654.7	216
Level of informatization and logistics infrastructure (%)	75.2	37.9	97.5	31.5	216
Professional level of labors (%)	67.3	28.3	104.7	17.1	216
Level of Logistics transportation (%)	77.1	25.5	193.4	9.4	216
Capital stock (million dollars)	1273.8	737.6	4961.3	753.8	216

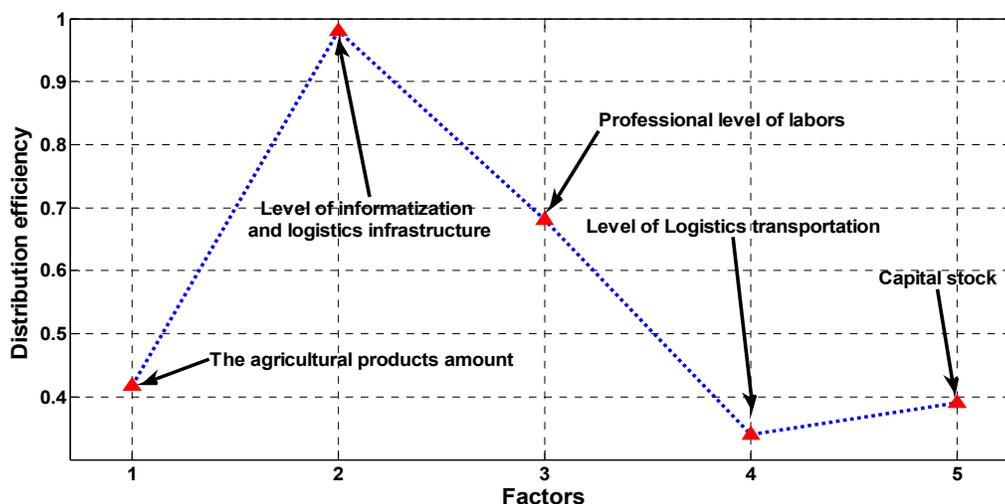


Fig. 2: Distribution efficiency of the influence factors in input analysis

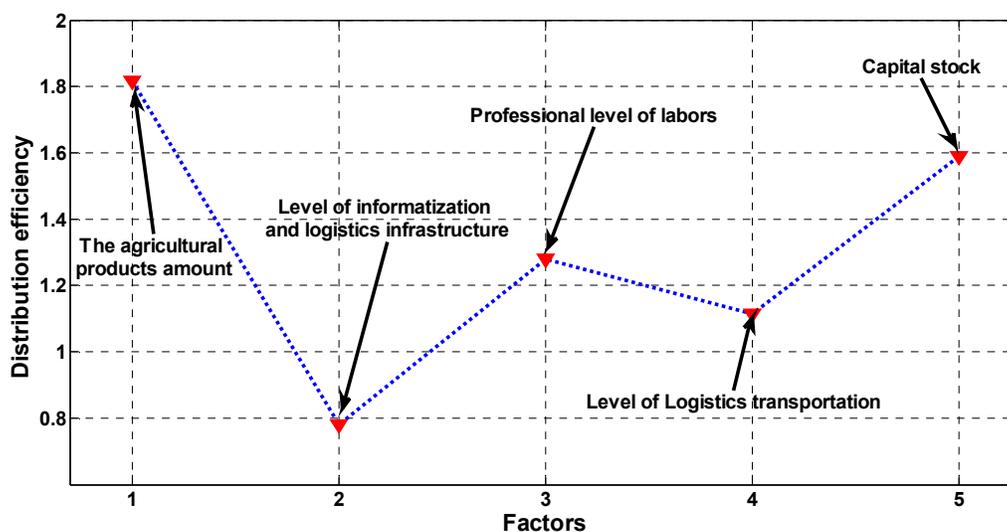


Fig. 3: Distribution efficiency of the influence factors in output analysis

development. Our country should focus to the rural infrastructure construction and investment to improve the dynamics of the agricultural distribution system. Government should continue to strengthen the construction of rural information network, combined with the needs of the different parts of the new rural construction.

- Increase the budget on rural human capital:** Rural labor force quality is an important factor to decide the agricultural distribution system. With China's western development plan and implementation of recovery plan of central China, the rural economy in west and central parts will enter a higher stage of development and the distribution of agricultural products will continue to strengthen the role of human capital. Therefore, improving investment in human capital in rural areas and the population quality in rural areas should be carried out under the guidance of market mechanism and policy to make high quality rural human capital.

CONCLUSION

The distribution efficiency of agricultural products determines the health development of the agricultural economy. However, very limited work has been done to quantitatively investigate the influence factors in the agricultural distribution system. In order to address this issue, this study proposes a new method based on DEA to implement the quantitative analysis. Empirical analysis has been carried out to quantitatively evaluate the influence of five factors, including the agricultural products amount, level of informatization and logistics infrastructure, professional level of labors, level of Logistics transportation and capital stock. Based on

calculation and analysis on the five selected factors, the DEA has been adopted to analyze the influence degree of each factor on the distribution efficiency of agricultural products. The analysis results show that the level of informatization and logistics infrastructure greatly influence the distribution efficiency of agricultural products while the Logistics transportation and the professional level of labors do not promote the efficiency of agricultural distribution system. Since for the first time the quantitative analysis of influence factors has been carried out on the distribution efficiency of agricultural products, the findings of this study can provide the useful solutions for improving the distribution efficiency of agricultural products.

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