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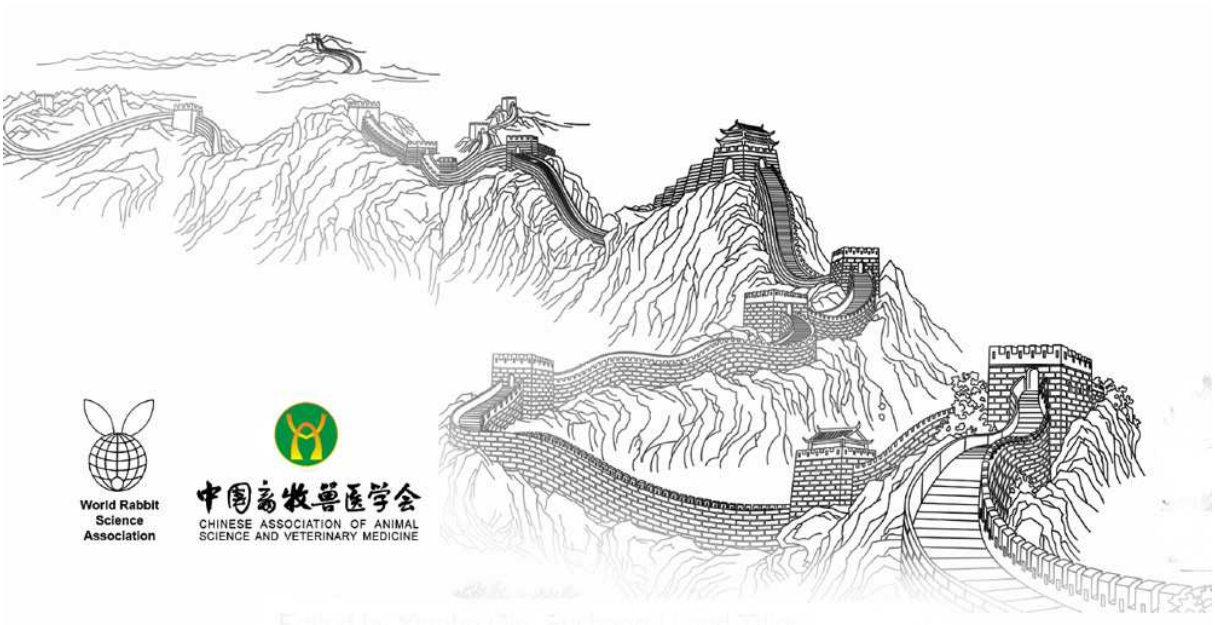

AN ANALYSIS OF TECHNICAL EFFICIENCY OF MEAT RABBIT BREEDING INDUSTRY IN CHINA

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ABSTRACT

China is the largest producer of rabbit in the world. This study applies surveyed data and DEA approach to analyze the technical efficiency of meat rabbit breeding industry. Firstly, this paper classifies the farms to small, medium and large-size by slaughtered rabbit number, then calculates production technical efficiency and the scale efficiency. Results show that the large-size farms have the highest scale efficiency, while the small-size farms have the highest pure technical efficiency leading to the highest comprehensive efficiency, which means the scale efficiency is still not achieved under the existing level of technology.

Key words: Technical efficiency, Meat rabbit, DEA method

INTRODUCTION

China has a long history in the breeding rabbits and has been the world's largest nation in the number of rabbit raised and slaughtered, meat output, and export of rabbit meat and fur. In order to ensure the sustainable development of rabbit industry, Chinese central government in 2009 launched a long term scheme of *China Rabbit Research System* (2009-2020), which focuses on technical progress and innovation of rabbit supply chain. The questions this study tries to answer are as follows: Whether does this program improve the technical efficiency in the industry? What are the efficiency differences among different farm sizes? Do the small size farms have lower pure technical efficiency?

METHODS AND DATA

There are two kinds of approaches to measure the economic efficiency of an industry: parametric and non-parametric approach. For parametric approach, a functional form needs to be specified, the producers should be assumed to be technically efficient, and the input elasticity needs to be estimated. The nonparametric approaches consist of index method and data envelopment analysis (DEA), in which, the function form does not need to be specified while the assumption that producers should be technically efficient is not necessary. The former needs certain behavioral assumptions, such as neutral technological progress, constant return to scale and competitive market, while the latter doesn't need those assumptions. Because of the above-mentioned facts, this study adopts the DEA way in the analysis.

Suppose there are n decision making units (DMU), i.e., farms, and each farm has K and M kinds of inputs and outputs. The input and output of farm i are x_i and y_i , respectively. Input matrix is $\boldsymbol{X}=K\times N$, and output

matrix is $\boldsymbol{Y}=M\times N$, where N is the number of DMUs. For each farm, all input and all output ratio can be obtained, such as $u'y_i/v'x_i$, where u is a vector of $M\times1$, v is a vector of $K\times1$. The best u and v can be found via the following mathematical form:

$$\begin{aligned} &\max_{u,v}(u'y_i / v'x_i) \\ s.t.\quad &u'y_{ij} / v'x_{ij} \le 1,\ \ j = 1,2,\cdots, N \\ &u \ge 0, v \ge 0 \end{aligned} \qquad (1)$$

For equation (1), there will be an infinite number of solutions. To avoid this problem, a constraint needs to be added: $v'x_i=1$.

$$\begin{aligned} &\max_{u,v}\ u'y_i \\ s.t.\quad &u'y_{ij} / v'x_{ij} \le 0,\ \ j = 1,2,\cdots, N \\ &u \ge 0, v \ge 0,\ \ v'x_i = 1 \end{aligned} \qquad (2)$$

By dual transformation, the formula (2) can be changed into the following forms:

$$\begin{aligned} &\min_{\lambda}\theta \\ s.t.\quad &\lambda y_{ij} \ge y_i,\ \ i = 1,2,\cdots, N \\ &\theta x_i - X\lambda \ge 0,\ \ \lambda \ge 0 \end{aligned} \qquad (3)$$

The equation (3)implies the constant return to scale (CRS), so the convexity restrictions need to be added $N_1'\lambda=1$,which is obtained in the form of variable returns to scale DEA's (VRS):

$$\begin{aligned} &\min_{\lambda}\theta \\ s.t.\quad &\lambda y_{ij} \ge y_i,\ \ i = 1,2,\cdots, N \\ &\theta x_i - X\lambda \ge 0 \\ &N_1'\lambda = 1, \lambda \ge 0 \end{aligned} \qquad (4)$$

From equation (4), the calculated TE can be decomposed into two parts: the pure technical efficiency and scale efficiency. In computing two DEA simulation by running the CRS and VRS, if we get two different TEs for the same DMU, it shows the DMU has scale efficiency. The scale efficiency can be obtained by dividing TE_VRS by TE_CRS.

The data used in this study comes from a yearly national field surveys in Anhui, Fujian, Hebei, Henan, Jilin, Jiangsu, Shangdong, Shanxi, Sichuan, Chongqing, and Yunnan during 2011- 2015. About 450 rabbit farms were surveyed each year in the 11 provinces, which includes 162, 171, 197, 129 and 197 rabbit farms, respectively, from 2011 to 2015. Based on the breeding scale classification for meat chicken and laying hens in The National Agricultural Cost-Benefit Data Collection compiled by the National Development and Reform Commission in China, this study classifies the farm types in terms of size into small-, medium-, and large-size farms. Table 1 reports the classification for the rabbit farms.

Table 1: The classification of farms in terms of size

Size type	Small-size	Medium-size	Large-size
Number of rabbit slaughtered (*N*)	$N\le 1000$	$1000 < N \le 10000$	$N > 10000$

RESULTS AND DISCUSSIONS

Using the VRS DEA method, this study calculates the technical efficiency for farms with different sizes. The estimates for the technical efficiency in the meat rabbit breeding industry are reported in Table 2. As shown in the table,the scale efficiencies from 2011 to 2015 are between 0.83 to 0.90 with small variations,

the pure technical efficiency (TE_VRS)ranges from 0.4927 to 0.6570 with large variations, and the comprehensive efficiency (TE_CRS) ranges from 0.4299 to 0.5915. Generally speaking, based on the stimates onboth the comprehensive efficiency and the pure technical efficiency, the technical efficiency in the industry is not high.

Table 2: Technical efficiency change of meat rabbit breeding, 2011-2015

Year	TE_CRS	TE_VRS	Scale Efficiency
2011	0.5605	0.6498	0.8710
2012	0.4414	0.4927	0.8986
2013	0.4299	0.5447	0.8309
2014	0.5915	0.6570	0.8944
2015	0.5635	0.6561	0.8522

In comparion with the technical efficiency across different provinces as shown in Table 3, results show that the estimated productions have quite large distance from the production frontier. For the comprehensive efficiency, the most efficient breeding industry is in Shanxi, where the coefficient estimate reaches 0.7826; the lowest is in Anhui, where the estimate is only 0.4394. For the pure technical efficiency, the industry in Shanxi is the highest while and the industry in Sichuan is the lowest. For scale efficiency, the industry in Yunnan is 0.9863 while it is 0.7559 in Anhui which is the lowest.

Table 3: Technical efficiency in different provinces

Province	TE_CRS	TE_VRS	Scale Efficiency
Anhui	0.4394	0.5696	0.7559
Fujian	0.5374	0.5990	0.8831
Hebei	0.6345	0.7320	0.7900
Henan	0.4717	0.5595	0.8587
Jilin	0.5159	0.5558	0.9316
Jiangsu	0.6737	0.7490	0.8933
Shangdong	0.4734	0.5455	0.8687
Shanxi	0.7826	0.8661	0.9012
Sichuan	0.4564	0.5047	0.9039
Chongqing	0.5044	0.6040	0.8449
Yunnan	0.5261	0.5334	0.9863

The results of technical efficiency on farms with different sizes are listed in Table 4. Results show that the medium-size farms have the lowest technical efficiency if it is evaluated by the estiamtes on comprehensive efficiency while the large-size farms have the lowest technical efficiency if it is evaluated by the estimates on the pure technical efficiency. Thus, although, the large- and medium-size farms have considerable scale efficiency under the existing level of technology, the small- size farms have the highest comprehensive efficiency due to larger loss of pure technical efficiency for the medium-and large-size farms as compared with the small-size farms.

Table 4: Technical efficiency of different sizes

Size type	TE_CRS	TE_VRS	Scale Efficiency
Small-size	0.5593	0.8567	0.6529
Medium-size	0.4918	0.5747	0.8587
Large-size	0.5237	0.5689	0.9163

By studying the changes in the technical efficiency from 2011 to 2015 (Table 5), this study found that the small-size farms have the highest the comprehensive efficiency in 2015, which is more than twice of those in the 2011. Although the scale efficiency of the small-size farms in 2015 are the lowest, theirs comprehensive efficiency is higher than large- and medium-size farms because they have the highest pure

technical efficiency in 2015.The pure technical efficiency for the small-size farms have been more than 0.9 since 2012, implying that the small-size farms havethe highest pure technical efficiency currently.
The loss of the comprehensive efficiency for the medium-size farms is bigger. As shown in table 5, the maximum value of the comprehensive efficiency is only 0.5828 while the loss value is 0.4172. There is a significant gain in the scale efficiency from the medium-size farmsto the small-size farms . However the comprehensive efficiency of the medium-size farms is lower than that of the small-sizefarms because of their larger loss of the pure technical efficiency.

The variations in the comprehensive efficiency for the large-size farms, which maintain between 0.4 to 0.6, are the smallest over the past five years.. The scale efficiency of large-size farms is greater than those of the medium- and small-size farms. Results show that the scale efficiency for large-size farms maximized in 2012, which almost is two time as much as that of the small-size farms of the year. However, the pure technical efficiency of large-size farms is lower than taht of small- and medium-size farms,which leads to the lower comprehensive efficiency for large-size farms.

Thus, it is found that there is a significant scale efficiency in the rabbit breeding industry though samll size farms have higher comprehensive efficiency as compared to the medium- and large-size farms because of the limitation of technology currently.

Table 5: Technical efficiency change of different sizes from 2011 to 2015

	TE_CRS			TE_VRS			Scale Efficiency		
	Small -size	**Medium -size**	**Large -size**	**Small -size**	**Medium -size**	**Large -size**	**Small -size**	**Medium -size**	**Large -size**
2011	0.4044	0.5828	0.6034	0.6564	0.6385	0.6380	0.6312	0.9115	0.9436
2012	0.4860	0.3639	0.5024	0.9720	0.4538	0.5136	0.4920	0.8193	0.9706
2013	0.4101	0.4475	0.4061	0.9067	0.5486	0.4193	0.4529	0.8272	0.9626
2014	0.1073	0.5313	0.6323	0.9203	0.6611	0.6504	0.1220	0.8087	0.9536
2015	0.8155	0.5550	0.4965	0.9058	0.6028	0.6162	0.8949	0.9190	0.8006

CONCLUSIONS

The results of this study show that both the comprehensive efficiency and pure technical efficiency don't change much from 2011 to 2015, suggesting that the technical innovation has not yet played an important role. From regional difference perspective, the farms in Shanxi province have both the highest pure technical efficiency and the comprehensive efficiency, the farms in Yunnan province the highest scale efficiency, the farms in Anhui the lowest comprehensive efficiency, and the farms in Sichuan the lowest pure technical efficiency. For the point of view of the scale efficiency, the small-size farms have both the highest comprehensive efficiency and the pure technical efficiency.

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An analysis of technical efficiency of meat rabbit breeding industry in China

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