SME technical efficiency and scale revenue calculation methods and selection of indicators

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Abstract

In the SME technical efficiency and scale gains calculation method, we give estimates of technical efficiency and scale gains SMEs theoretical approaches and models, discuss the DEA method in research methodology and modelling methods. Model can be used to evaluate whether the decision-making unit for both technical efficiency and scale gains effective and to determine the scale of decision making unit gain position. Model can only technical efficiency of decision making units makes evaluations. If organically combined use of these two models, comprehensive analysis, we can get more valuable information. And further clarified the decision making units with DEA method to evaluate technical efficiency and scale gains steps. Also given the choice of indicators and access methods, a clear DEA model is mainly selected input and output indicators.

Keywords: SME technical efficiency index system returns to scale

1 Introduction

Since the 1980s, the annual output growth of SMEs in China has remained at about 30%, much higher than the overall economic growth rate. As of the end of June 2012, the number of SMEs in China has reached more than 4200 million, accounting for the total enterprises 99.8 percent, of which, by the business sector registered number of 4.6 million SMEs, more than 38 million self-employed households households. SMEs in the GDP, the proportion of taxes and import and export, respectively, accounted for 60%, 53% and 68% or so. Meanwhile, SMEs provide about 75 percent of urban jobs, 80% of state-owned enterprises laid-off workers were re-employed in SMEs. Moreover, 66% of invention patents, more than 82% of new product development is done by the SMEs. SMEs are not only economic and social development of an important force, but also China's market economy the most dynamic part. The advantage of SMEs small and fine, small and specialized, small and live, in carrying out technological innovation activities has incomparable advantages of large enterprises, more than 75% of independent innovation products, more than 80% of patents are completed SMEs . China's foreign trade import and export volume of about 60% is provided by the SME, SME export trade to the rapid development of the national economy plays a huge role in promoting. Therefore, strengthening support for SMEs and nurturing for the sustainable development of the national economy, has important significance.

2 C^2R the model building method

R assumes the existence of a decision-making unit, and each decision-making unit exists n types of input factors and output indicators of m, respectively, indicate that the unit "effectiveness" and "cost of resources," as shown in Table 2-1.

TABLE 2-1 Input and Output Data Table of DEA Method

	Weights	Decision-making unit			
		1	2	… …	r
Input indicators 1	v_1	x_{11}	x_{12}	… …	x_{1r}
Input indicators 2	v_2	x_{21}	x_{22}	… …	x_{2r}
⋮	⋮	⋮	⋮	⋮	⋮
Input indicators n	v_n	x_{n1}	x_{n2}	… …	x_{nr}
Output indicators1	u_1	y_{11}	y_{12}	… …	y_{1r}
Output indicators2	u_2	y_{21}	y_{22}	… …	y_{2r}
⋮	⋮	⋮	⋮	⋮	⋮
Output indicators m	u_m	y_{m1}	y_{m2}	… …	y_{mr}

The following relation

$$\eta_j = \frac{\sum_{k=1}^{m} u_k y_{kj}}{\sum_{i=1}^{n} v_i x_{ij}} \qquad j = 1,2,\cdots\cdots r$$

The efficiency of the decision-making unit evaluation index.

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Can always choose appropriate weights v_i and u_k make it satisfied.

Evaluation of the relative effectiveness of a decision-making process j_0 units to the DMU efficiency index for the j_0 target, and the weight coefficients for the variables to ensure that all decision-making unit efficiency index for the constraint $\eta_j \le 1$ ($j = 1,2,\cdots\cdots r$) . Related to the C^2R model is:

$$C^2R\begin{cases}\max \eta_{j_0} = \dfrac{\sum_{k=1}^{m} u_k y_{kj_0}}{\sum_{i=1}^{n} v_i x_{ij_0}} \\ s.t \\ \dfrac{\sum_{k=1}^{m} u_k y_{kj}}{\sum_{i=1}^{n} v_i x_{ij}} \le 1 \qquad j = 1,2,\cdots,r \\ u_k \ge 0 \qquad k = 1,2,\cdots,m \\ v_i \ge 0 \qquad i = 1,2,\cdots,n\end{cases},$$

where v_i is the index of the first types of input i weights;

u_k Output indicators for the first types of k weights;

x_{ij} For the first two types of decision making j unit input to the first i input of the amount;

y_{kj} For the first two types of decision making j unit output of the first k volume of output.

Used to check Enns - Cooper (Charnes-Cooper) transformation,

Order

$$t = \frac{1}{\sum_{i=1}^{n} v_i x_{ij_0}} \tag{2-3}$$

$$\omega_i = tv_i \qquad i = 1,2,\cdots\cdots,n \tag{2-4}$$

$$\mu_k = tu_k \qquad k = 1,2,\cdots\cdots,m \tag{2-5}$$

The derivation may:

$$L\begin{cases}\max v_L = \sum_{k=1}^{m} \mu_k y_{kj_0} \\ s.t \\ -\sum_{i=1}^{n} \omega_i x_{ij} + \sum_{k=1}^{m} \mu_k y_{kj} \le 0 \qquad j = 1,2,\cdots,r \\ \sum_{i=1}^{n} \omega_i x_{ij_0} = 1 \\ \omega_i \ge 0 \qquad i = 1,2,\cdots,n \\ \mu_k \ge 0 \qquad k = 1,2,\cdots,m\end{cases}$$

where $\omega^T = (\omega_1, \omega_2, \omega_3, \cdots, \omega_n)$ represents the weight of each factor inputs, $\mu^T = (\mu_1, \mu_2, \mu_3, \cdots, \mu_m)$ which means that the weight of each output elements.

3 C^2GS^2 the modeling approach

Theoretically speaking, the firm is likely to gain in technical efficiency and scale in both directions to achieve the best condition. But in fact, due to the presence of some reason, these two aspects are the best is that there are certain practical difficulties. Then choose whether companies often will only achieve the best in terms of technical efficiency, the model C^2GS^2 is to measure the technical efficiency of enterprises specifically put forward.

1985 B.Celany cooperation with Charnes et al proposed C^2GS^2 measuring enterprise specialized technical efficiency model, which not only can effectively make a correct estimate of the production frontier, and can determine whether each decision unit technology effecttively, and thus can calculate the size of its technical efficiency.

Let there n kind of investment, r decision-making unit, and m output, total $n+m$ evaluation indexes. Observed X_j, Y_j) by the production activities (($j = 1,2,\ldots,r$) generated by the production possibility set T (convex polyhedron), namely:

$$T = \left\{(X,Y) \middle| X > \sum_{j=1}^{r} \lambda_j X_j, Y < \sum_{j=1}^{r} \lambda_j Y_j, \sum_{j=1}^{r} \lambda_j = 1, \lambda_j > 0, \lambda = 1,2,\cdots,r\right\}$$

Located on the boundary decision unit called technology effectively; located inside the spot, known as non-technical valid units. In this C^2GS^2 model the production possibility set is analyzed on the technical non-valid reasons, given improvement program. For a production unit DMU_{j0} from input perspective, the establishment of the production possibility set T of production technology with DEA C^2GS^2 Models:

$$(D_1)\begin{cases}\min \theta = V_D \\ s.t \\ \sum_{j=1}^{n} \lambda_j X_j + s^- = \theta X_0 \\ \sum_{j=1}^{n} \lambda_j Y_j - s^+ = Y_0 \\ \sum_{j=1}^{n} \lambda_j = 1 \\ \lambda_j \ge 0 \qquad j = 1,2,\cdots,n\end{cases} \tag{3-1}$$

The formula for the dual problem

$$(P_1)\begin{cases}\max(\mu^T Y_0 - \mu_0) = V_P \\ s.t \\ \omega^T X_j - \mu^T Y_j + \mu_0 \ge 0 \qquad j = 1,2,\cdots,n \\ \omega^T X_0 = 1 \\ \omega \ge 0, \mu \ge 0\end{cases} \tag{3-2}$$

The significance of the DEA model to ensure that output is not reduced in the case, try to make the various

inputs in the same proportion reduced, while the slack variables s^-, s^+ gives the evaluation of the production unit input-output structure adjustment information. The method for the evaluation of each decision-making unit, decision making unit is not only able to give effective and non-effective when the improvement program, but also can simultaneously estimate the frontier production function. Although this estimate frontier production function is not given concrete form, but it gives any production activities (X, Y) in the production of the corresponding point on the boundary.

In 1998, Mao Shiping, etc. will be put into technical efficiency and output technical efficiency are defined as the technical efficiency of inputs and outputs of technical efficiency of the mean, as described below

Into technical efficiency:

$$ITE = \frac{1}{n}\sum_{i=1}^{n} ITE_i = \theta - \frac{1}{n}\sum_{i=1}^{n} s_i^- / X_i$$

Output technical efficiency:

$$OTE = \frac{1}{r}\sum_{j=1}^{r} ITE_j = 1 - \frac{1}{r}\sum_{j=1}^{r} s_j^+ / \hat{Y}_j$$

Where θ the effectiveness of the decision-making cell technology;

The structure s_i^- / X_i for the first two i inputs loss of technical efficiency;

The structure $s_j^+ / \hat{Y}_j$ of the output loss j of technical efficiency.

Technical efficiency of decision making units, ie comprehensive technical efficiency can be expressed as:

$$TE = ITE \times OTE = (\theta - \frac{1}{n}\sum_{i=1}^{n} s_i^- / X_i)(1 - \frac{1}{r}\sum_{j=1}^{r} s_j^+ / \hat{Y}_j)$$

Definition 3: If the linear programming problem (P_1) there is an optimal solution $\omega^0, \mu^0, \hat{\mu}_0$ and meet $V_P = \mu^{0T} Y_0 - \hat{\mu}_0 = 1$. Called weak DEA efficient j_0 decision making unit (C^2GS^2); Also, if there are further $\omega^0 > 0, \mu^0 > 0$, can be said for the DEA efficient j_0 decision-making unit (C^2GS^2).

As a means of identification, we have introduced the above two planning infinitesimal non-Archimedean ε, we have:

$$(P')\begin{cases} \max \ (\mu\ y_{j0} - \mu_0) = V_P(\varepsilon) \\ s.t. \\ \quad \sum_{i=1}^{n} \omega_i x_{ij} - \mu\ y_j + \mu_0 \geq 0 \qquad j = 1,2,\cdots,n \\ \quad \sum_{i=1}^{n} \omega_i x_{ij} = 1 \\ \quad \omega_i \geq \varepsilon, \mu \geq \varepsilon \end{cases} \tag{3-3}$$

Its dual programming as:

$$(D')\begin{cases} \min \ [\theta - \varepsilon(\sum_{i=1}^{n} s_i + s)] = V_D(\varepsilon) \\ s.t. \\ \quad \sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{ij0} \\ \quad \sum_{j=1}^{n} \lambda_j Y_j - s_k^+ = y_j \\ \quad \sum_{j=1}^{n} \lambda_j = 1 \\ \quad \lambda_j \geq 0, j = 1,2,\cdots,n \qquad s_i^- \geq 0, s_k^+ \geq 0 \end{cases} \tag{3-4}$$

Let linear programming problem (D') is the optimal solution $\lambda^0, s_i^{-0}, s_k^{+0}, \theta^0$ according to the evaluation results the following theorems.

Theorem 6: (a) If $\theta^0 = 1$, however $s_i^{-0} \neq 0$, or $s_k^{+0} \neq 0$ when called weak DEA efficient decision making unit j_0 (C^2GS^2). At this time, does not reduce the output of the premise, not narrow scale of investment. However, this time due to the irrational structure of inputs or outputs, resulting in non-technical structure effective structure technology brings efficiency loss;

(2) if $\theta^0 = 1$ and $s_i^{-0} = 0, s_k^{+0} = 0$ when called j_0 DEA efficient decision-making unit (C^2GS^2), that is, its input and output and the structure of the technical efficiency of 100%. In this case, the production in the ideal state;

(3) $\theta^0 < 1$ non-technical decision-making unit then known as effective, in terms of relative output at this time, there is a large-scale investment and other issues.

Also, if $s_i^{-0} \neq 0$, or $s_k^{+0} \neq 0$, if there is input or output structure is irrational, the technical efficiency of the decision-making unit is less than 100%, the need for input and output to be adjusted. In this case, adjust the following principles:

$$\hat{x}_{ij_0} = \theta^0 x_{ij_0} - s_i^{-0} \tag{3-5}$$

$$\hat{y}_{kj_0} = y_{kj_0} + s_k^{+0} \tag{3-6}$$

4 Input indicators and output indicators

4.1 INPUT INDICATORS

The DEA model is mainly Select All average number of employees, sales, total assets, net fixed assets, current assets average balance of these five indicators to be measured input.

(1) Annual Average number x_1 refers to the operating companies acquired during the period the number of human resources. As officers in the business during is flowing, so the number of employees during the operation can be represented by the average number of years.

(2) sales of an enterprise x_2 in the business during the event, the number of annual sales.

(3) Total assets x_3, an enterprise controlled or owned economic profit can bring to the enterprise resources. Including plant site, monetary funds, raw materials, machinery and equipment, and so is the enterprise production and management activities necessary material basis, though there are those who have the physical form, but contribute to the production activities of trademarks, patents and other intangible assets , also includes other units of investment.

(4) Net fixed assets x_4 is depreciated amount minus the calendar year, the remaining net fixed assets.

(5) The average balance of current assets x_5, current assets occurred in the process of production and operation of enterprises, is a short-term asset kept as liquid assets such non-fixity of nature, we take the average balance of current assets as inputs indicators.

4.2 OUTPUT INDICATORS

This DEA model selected industrial output, industrial sales output value, profits and taxes total output of these three representative indicators to measure.

(1) Industrial output y_1, total output value of an enterprise that year.

(2) Industrial sales output y_2 value of an enterprise's total product sales.

(3) Total profit y_3, total profit of an enterprise product, VAT and sales tax and additional sum.

5 Conclusions

Through this research, given estimates of technical efficiency and scale gains SMEs theoretical approaches and models, discuss the DEA method C^2R in research methodology and modeling modeling methods C^2GS^2. Model C^2R can be used to evaluate whether the decision-making unit for both technical efficiency and scale gains effective and to determine the scale of decision making unit gain position. Model C^2GS^2 can only technical efficiency of decision making units make evaluations. If organically combined use of these two models, comprehensive analysis, we can get more valuable information. And further clarified the decision making units with DEA method to evaluate technical efficiency and scale gains steps. Also given the choice of indicators and access methods, defined the main DEA model selected paper input and output indicators. Assessment is a prerequisite for policy-making and the fundamental basis. DEA method can be effectively applied on the premise that an objective and correct evaluation index system of input and output options.

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