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Logistics Enterprise X Efficiency Measurement Based on SFA

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Abstract: With 4A logistics enterprises in Jilin Province as the research object, through to measure 4A efficiency of logistics enterprises Jilin province, analysis the logistics enterprise's efficiency to improve the management level of enterprises, Meanwhile reflect 4A logistics enterprise operation process to the allocation of resources and application of technology capability Jilin province, help the logistics enterprises in Jilin province and analysis the production cycle of the deficiencies and to explore the efficient causes, in favor of logistics enterprises to improve efficiency Jilin Province, enhance the market competitiveness of logistics enterprises in Jilin province. In this study, using the Stochastic Frontier Approach (SFA) measure 4A X efficiency of logistics enterprises in Jilin province, the logistics enterprises in the efficiency level of comparative studies, analysis of the reasons for the lack of efficiency of logistics enterprises and puts forward the idea of efficiency improving.

Key words: SFA, Logistics enterprise, X efficiency, Jilin Province

STOCHASTIC FRONTIER ANALYSIS (SFA) BASIC THEORY

Production frontier theory: Economics is based on the rational "economic man" hypothesis, namely in the fixed input output (profit) to maximize, or in a predetermined output input (cost) to minimize as much as possible. Later, economists in order to improve the average production function defects, started on the frontier production function theory is discussed. Description of production frontier production function can be referred to as the frontier production function or boundary production (Aigner *et al*., 1977) .

Assuming there are M a Decision Unit (DMU), while it is assumed that each DMU has N inputs and the i DMU multiple inputs per unit area yield data vector set (X_i, Y_i), $X_1 = (x_{i1}, \ldots, X_{iN})$. Then the Farrell model modeling are as follows:

$$\begin{aligned} &\min_{\beta} f_i = \sum_{j=1}^{n} x_{ij}\beta_j \\ &\text{s.t.} \sum_{j=1}^{n} x_{ij}\beta_j \geq Y_i \qquad i = 1, \cdots, M \\ &\beta_j \geq 0 \qquad\qquad j = 1, \cdots, N \end{aligned} \tag{1}$$

Aigner and Chu (1968) Farrell model is modified and the following model:

$$Y_i = f(x_i, \beta) \exp(-\mu_i) \tag{2}$$

Equation 2 using Cobb-Douglas production function, its form:

$$\ln y_i = \beta_0 + \sum_j \beta_j \ln x_{ij} - u_i \tag{3}$$

Type 1 2, $\exp(-\mu_i)$ is rated decision unit technical efficiency, make its value not greater than 1, $\mu_i > 0$ is required, then can get the following programming model:

$$\begin{aligned} &\text{Min} \sum_i u_i \\ &\text{s.t.} \quad \beta_0 + \sum_j \beta_j \ln x_{ij} \geq \ln y_i, \quad u_i \geq 0 \end{aligned} \tag{4}$$

Stochastic frontier analysis method including the stochastic frontier cost function analysis and stochastic frontier production function analysis. Aigner, Lovell and Sehmidt (Battese and Coelli, 1992), Meeusen and Van den Broeck (Battese and Coelli, 1995) and Battese and Corra (Aigner and Chu, 1968) were independently proposed a stochastic frontier production function model.They put forward the basic model can be expressed as:

$$Y = f(x, \beta) .\exp(v-u) \tag{5}$$

On the type, y stated output, x input, β parameters. v to N $(0, \sigma^2_v)$ distribution, ϵiid.u0 of a DMU individuals have the impact and influence.

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Battese and Coelli models: According to the study time and the applied stress is different, the Battese and Coelli model can be divided into Battese and Coelli (1992) model of and Battese and Coelli (1995) model. Among them, Battese and Coelli (1992) model can be expressed as follows:

$$y_i = x_i\beta+(v_i-u_i)\ i = 1, 2,\cdots, N \quad (6)$$

In Eq. 6, it is assumed that N enterprises, of which, y_i output, x_i input, β for unknown parameters. Error by v and u is composed of two parts, between the two mutual independent. Among them, v_I are considered as random variables, u_i is non-negative random variables.

Battese and Coelli models: Battese and Coelli (Battese and Corra, 1977) model is able to deal with the cross section data and the balanced and unbalanced panel data and can be calculated from the selected samples the average technical efficiency and technical efficiency level of each enterprise. Battese and Coelli (1995) model is mainly composed of Eq. 7 and 8 is composed of two parts:

$$y_{it} = x_{it}\beta+(v_{it}-u_{it})\quad i = 1, 2,\cdots,T \quad (7)$$

$$m_{it} = Z_{it}.\delta \quad (8)$$

In Eq. 7, y_{it}, x_{it} and β were in the previous consistent meaning. In Eq. 8, Z_{it} as a group used to explain differences between enterprises efficiency of real variables, δ for a corresponding set of parameters to be estimated. And Battese and Coelli (1992), they are still set parameters:

$$\gamma = \frac{\sigma_u^2}{\sigma_v^2+\sigma_u^2}$$

At present, Frontier program is academic as the most widely used SFA technology and special program, which helps researchers to further understand the formation between enterprises technical efficiency difference (Zhu, 2004) .

(SFA) of stochastic frontier model: In existing literature, the scholars mainly using production function with Cobb-Douglas production function, logarithmic function, generalized translog function and Fu Liye function and so on flexible.Among them, the most widely used, the impact is the biggest is Cobb-Douglas production function and logarithmic function (translog function), this study mainly introduces the two kinds of function in logistics industry X efficiency measurement of model construction.

Based on the C-D production function SFA model construction:Based on the Cobb-Douglas production function of nonlinear logistics efficiency expression for X:

$$Y = AX_1^{\alpha}X_2^{\beta}X_3^{\gamma} \quad (9)$$

In solving the logistics efficiency of X, can use the logarithmic form:

$$InY = InA+\alpha InX_1+\beta InX_2+\gamma InX_3 \quad (10)$$

On the type, X_1, Y_2, X_3 for the logistics industry in the production process of the various elements for input, Y output factor, constant express logistics enterprises fixed costs, α, β, γ, respectively, said that the investment elasticity coefficient.

The establishment of SFA model based on Translog: In the logistics industry efficiency studies, foreign scholars use most is the Translog Cost Function (TCF), because the function in the process of using the less restricted conditions. This is based on the measurement of logistics industry in Jilin province by X efficiency model.

Usually, we use the Translog Cost Function (TCF) to estimate the cost function, its general form can be expressed as follows:

$$InTC = f(y, p) \quad (11)$$

In which, TC, y, p, respectively, said to be estimated the total cost of logistics enterprises, the output of the logarithmic vector and input prices of logarithmic vector.Here, can use Maclaurin expansions will be shown in a Eq.11 translog cost function deformation for:

$$\ln TC = \alpha_0 + \sum_i \alpha_r \ln Y_i + \sum_m \beta_m \ln P_m + \frac{1}{2}\sum_n\sum_m \alpha_{nm} \ln P_m \ln P_n + \frac{1}{2}\sum_i\sum_j \beta_{ij} \ln Y_i \ln Y_j + \frac{1}{2}\sum_i\sum_m \gamma_{im} \ln Y_i \ln P_m + \varepsilon \quad (12)$$

In Eq. 12, Y_I logistics enterprises i outputs, P_m express logistics enterprises m inputs the market price, ϵ random error.

Empirical analysis: Samples and data selection: From the logistics enterprises in Jilin province and the history of the development of distribution situation in Jilin Province, the International Logistics Limited, Changchun FAW international logistics center, Northeast China Railway Materials Group Co., Jilin City, Hong Kong and inland freight company limited, Jilin province Tian Rong Industry and trade limited liability company, Changchun City Aceh

Logistics limited company, FAW car company limited storage center, Jilin International Logistics Limited, the bed in Changchun City Express Limited company and Jilin province Longyuan agricultural means of production group limited company ten enterprises such as the representative. Both joint ventures, state-owned enterprises and private enterprises also have. More than ten logistics enterprises in the current Jilin Province logistics production capacity accounted for over 60% of production, the development of the logistics industry in Jilin province is a typical and representative.

The purpose of this study is not only to the selected sample enterprise X-efficiency were compared but also the need for all enterprises in recent years the development of vertical contrast, therefore, to determine the study life of 2005-2010 years. The six years of the logistics industry in Jilin Province in the golden period of development, can reflect the current Jilin Province logistics industry development and trend. In above research conditions, according to the above construction of input and output index, through access to 2006-2011 year "Jilin Province logistics yearbook" and supplemented with proper research (mainly in the logistics enterprise data report), to Jilin Province ten typical 4A logistics enterprise 2005-2010 input-output data.

Empirical analysis of efficiency estimation: How to produce the function the form of choice, is to use the SFA method to face an important question. According to Wang Lin's research results (Wang and Wu, 2005), different function forms of measurement efficiency values will vary. But no matter using panel data model or the cross section data model, in Cobb-Douglas and Translog production function under the rated value of decision-making and unit efficiency ranking is highly relevant, i.e. different function forms have no significant effect on efficiency ranking. Therefore in the empirical study should be possible with less restrictive form of choice, more flexible functional form to estimate.

In this study, firstly, the structure of the simple Cobb-Douglas production function Jilin province for year 2005-2010 X-4A logistics enterprise efficiency estimation, the estimation results as shown in Table 1.

Table 1 shows, β_0, β_2 and β_3 were tested by T, therefore, the use of Cobb-Douglas production function is not appropriate.We may consider to form more flexible, more flexible production function Translog on 2005-2010 4A X-in Jilin Province logistics enterprise efficiency estimation, the estimation results as shown in Table 1.

In the Translog production function form, all have passed the T-test of regression coefficient $LR = 33.5825 > \chi^2_{0.99}(10) = 23.2.9$. In 0.01, the significance

Table 1: C-D production function regression results

Coefficients	Return value	Standard deviation	T-test value
β_0	-2.0165	3.0517	-0.6608
β_1	1.1250***	0.3154	3.5666
β_2	0.0535	0.0784	0.6818
β_3	-0.1225	0.3086	-0.3969
σ_2	0.9694	0.8884	1.0911
γ	0.8076***	0.1803	4.4802
Log likelihood function	-47.4059		
LR test of the one-sided error	32.4851		

Invalid rate variability of total variance ratio, value significantly, said that the Frontier method is suitable, ***: Police said the significant level of 1%, **: Said significant amounts to 5%, *:Indicates a significant difference at 10%

Table 2: Translog production function regression results

Coefficients	Return value	Standard deviation	T-test value
β_0	774.4599*	585.7306	1.4222
β_1	-67.2144*	43.6164	-1.5410
β_2	-56.4033*	47.9921	-1.5753
β_3	-74.8364*	66.4492	-1.4262
β_4	1.2339*	0.7381	1.6717
β_5	-0.0035*	0.0589	-1.5592
β_6	1.3239**	0.6009	2.2030
β_7	4.2587*	3.4111	1.6485
β_8	4.0014**	4.5438	1.8806
β_9	6.6123*	5.5276	1.6962
β_{10}	-0.4976*	0.3934	-1.5648
σ_2	0.7924**	0.3761	2.1070
γ	0.8207***	0.084	9.7738
μ	1.0073**	0.5382	1.8717
log likelihood function	-40.7917		
LR test of the one-sided error	33.5825		

Invalid rate variability of total variance ratio, value significantly, said that the Frontier method is suitable, ***: Police said the significant level of 1%, **: Said significant amounts to 5%, *: Indicates a significant difference at 10%

level through the likelihood ratio test, showed that 4A of Jilin Province logistics enterprises exist technical inefficiency, suitable for the use of SFA model to estimate (Meeusen and Broeck, 1977) . The 4A logistics enterprise efficiency estimates are as shown in Table 3.

Analysis: First, the selected Translog production function in 0.01 significant level through the likelihood ratio test, showed that the 4A logistics enterprise exists inefficiency, the use of SFA estimation is suitable. Because the = 0.8207, indicating the error term of more than 80% is due to inefficiency, while less than 20% is due to random errors.

Second, since this is the calculation of the relative efficiency of the logistics enterprises, the efficiency value of size is no practical meaning, we are more concerned about the logistics enterprises efficiency ranking.From efficiency ranking situation, Changchun FAW international logistics center, Changchun City COSCO Express Limited company, FAW Jiefang Automotive Company Limited storage center, Jilin City, Hong Kong and inland freight limited company and Jilin province

Table 3: 4A logistics enterprise efficiency and ranking

Company name	2005	2006	2007	2008	2009	2010	Mean value	Ranking
Jilin city inland harbor freight limited	0.7445	0.5969	0.5177	0.6511	0.7578	0.7145	0.6638	4
FAW car company limited storage center	0.7537	0.6576	0.5190	0.7093	0.7944	0.6991	0.6889	3
Northeast China railway materials group limited	0.7265	0.2105	0.6546	0.6632	0.7495	0.6279	0.6054	7
Jilin tian rong industry and trade limited liability company	0.4640	0.3545	0.2278	0.4220	0.4895	0.3412	0.3832	10
International logistics company limited in jilin province	0.7107	0.6306	0.6064	0.6726	0.5165	0.6655	0.6337	5
Changchun city COSCO express limited	0.7111	0.7782	0.7446	0.7651	0.7498	0.7685	0.7529	2
Changchun city aceh logistics limited	0.6804	0.5369	0.5036	0.5816	0.6382	0.6783	0.6032	8
Changchun FAW international logistics center	0.6939	0.6703	0.7555	0.7683	0.8246	0.8763	0.7648	1
Jilin province longyuan holdings limited means of agricultural production	0.5647	0.4325	0.6755	0.7167	0.6344	0.4346	0.5764	9
Jilin international logistics limited bed	0.6739	0.6315	0.6017	0.5847	0.6139	0.5969	0.6171	6

Faldan International Logistics Company Limited were ranked the top five and top two in Jilin province is the source of agricultural means of production group limited the company and Jilin province Tian Rong Industry and trade limited liability company. Thus, joint logistics enterprise technical efficiency is relatively high, mainly due to the joint venture directly introduce the foreign logistics enterprises advanced management means and experience. The state-owned enterprise and private enterprise technical efficiency is relatively low, this is mainly because Jilin Province logistics industry starts later, every area and foreign capital enterprise existence difference.

From the efficiency of the annual variation tendency, Jilin province 4A logistics enterprise efficiency value in 2005-2010 wave is not obvious, showed no overall increase or decrease trend. For most businesses, in 2005 the technical efficiency is relatively high, basically after 2006, showing a rising trend, the occasional individual year last year on the basis of decline, mainly due to the frontier and the actual production function of the widening gap between the technical inefficiency at growth and the change of market environment in.From each enterprise relative efficiency, the annual variation amplitude.This indicates that the enterprises in Jilin logistics industry in the rankings by external factors.

From the 4A enterprise efficiency gap change, each year 4A enterprise efficiency maximum value and the minimum value differences by 2005 0.2897 gradually expanded to 0.5677 in 2006, then each year to drop somewhat, the technical level, level of management and the change of market competition environment, all enterprises between the relative gap is narrowing stage by stage. That is to say, from the logistics enterprise interior reason did not make full use of existing resources or opportunities for profit differences overall in narrowing in year after year, this accords with Jilin Province logistics industry development trend. Along with the technical level, management level and market competition environment gradually mature, various enterprises technology sharing and management skills are more and more fully, in the current domestic logistics industry, a dominant approximate monopoly is being broken, diversified competition pattern is preliminary already form.

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