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The Measurment and Comparison of Technical Efficiency Between Public and Private Textile Industry in Iran

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ABSTRACT

This paper is concerned with the estimation of frontier production function to measure the technical efficiency for Iranian textile companies during 1995. The objective of this estimation is to investigate if there are any differences in the technical efficiency between the private and public firms as well as the relationship between technical efficiency and size of textile companies in Iran. A Translog stochastic production function is used for this purpose. Maximum Likelihood method is used to estimate parameters of the model and predict technical efficiency for each enterprise. Empirical results show that most of the enterprises are operating at high level of efficiencies. The overall mean efficiency is 84%, indicating that, on average, there exists potential for an increase in output of 16%. Public firms are found to operate more inefficiently than private ones. A negative relationship between number of labor and technical efficency is recognized.

JEL Classification: C21, D21

Keywords: Technical efficiency, Stochastic frontier production, Textile industries, Translog function.

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1. Inroduction

The theoretical definition of production function expressing the maximum amount of output obtainable from given input bundles with fixed technology has been accepted for many decades. In empirical studies, production functions have been traditionally described as average function estimating the mean output rather than the maximum output. It has only been since the pioneering work of Farrell (1957) that serious consideration has been given to the possibility of estimating the so-called "frontier production function", in an effort to bridge the gap between theory and empirical work. The literature on the estimation of frontier functions to measure economic efficiency of firms has been developed in different directions. In seeking to improve the theoretical basis for frontier production function models, economists have followed different paths based on parametric and non-parametric approaches. The stochastic frontier analysis (SFA) approach proposed by Aigner, Lovell and Schmidt (1977) is based upon parametric specifications of functional forms for the frontier and the residuals invilved. Data envelopment analysis (DEA) approach specifies the production set only in terms of properties such as convexity and monotonicity, without imposing any parametric structure on it (Banker, Charnes, and Cooper 1984).

This paper is organized as follows. Specification and estimation of the models are discussed in Section 2. The data and definitions of variables are presented in Section 3. Empirical results are presented and discussed in Section 4. Section 5 offers a summary and conclusions.

2. Specification of the models

The stochastic frontier production for cross-sectional data is defined as:

$$Y_i = f(X_i\ ;\ \theta) \exp \varepsilon_i \qquad i=1,2,...,N \tag{1}$$

$$\varepsilon_i = V_i - U_i$$

Where Y_i denotes the production at the i-th form, X_i is a vector of values of inputs including labor, capital energy and material, and θ is unknown parameters to be estimated. The random variable, ε_i consists of two components. First, V_i, which is assumed to be statistical noise with i.i.d $N(0,\sigma_v^2)$. It represents effects which can not be controlled by the firms, i.e. changes in government decisions that affect the exchange rate, quality, access to raw material, labor market conflicts, trade issues, measurment errors in the dependent variable, and left-out explanatory variables. Second, techncial inefficiency, U_i, which is a non-negative random variable represents factors that can be controlled by the firm and are assumed to be independently distributed such that it is obtained by truncation (at zero) of the normal distribution, with the mean, μ_i, and the variance, σ^2 (see Battese & Coelil, 1995), Where μ_i is defined by

$$\mu_i = Z_i \tag{2}$$

Where Z_i is a vector of firm characteristics and is a vector of unknown parameter to be estimated. U_i and V_i are assumed to be independent. In some studies (e.g., Kumbhakar, Ghosh, and McGuckin (1991) and Battese and Coelil (1995) firm characteristics are assumed to directly affect technical efficiency. Then the underlying hypothesis is that all firms share the same technology represented by the production frontier (1) and that the firm characteristics have an influence only on the distance that separate the firms from the best-practice production.

The translog production function of equation (2) is expressed as:

$$Y_i = \beta_0 + \sum_j \beta_j x_{ji} + 1/2\{\sum_j \sum_k \beta_{jk} x_{ji} x_{ki}\} + V_i - U_i \tag{3}$$

Where Y is the log of output, X is a vector of the log of inputs (j= 1,2,...,J), and the β_s are unknown paramters to be estimated.

The following distributional assumptions on the error terms are imposed

i) V_i is i.i.d. $N(0,\sigma^2_v)$,

ii) U_i is i.i. d. N $(0,\sigma^2)$, truncated normal distibution,

iii) V_i and u_i independent and,

iv) The explanatory variables (x,Z) are non-stochastic, independent of V_i, and U_i.

The technical efficiency of production for the i-th firm is defined as the radio of actual output to maximum possible output:

$$TE_i = \exp(-U_i) \tag{4}$$

3. Description of data

The data used in this study cover a sample of 250 textile firms, consisting of both public and privately owned ones, operating in 1995. The data set includes output (y), labor cost (L), energy cost (E), material cost (M) and number of labor. Capital input is defined theoretically as the value of services of capital goods. Since data are not available for capital services, the value of fixed assets is used as a proxy variable for capital. The sources of data is the Iranian Statistical Center. Output is the value of aggregate output produced during the year. This implies that no changes in the stock of output have taken place. Labor (L) is defined as aggregate wages, including the payroll tax for all types of labor. Labor includes administrative personel, blue and white collar workers and managers. Energy cost (E) is measured as the expenditures on inputs, such as raw materials defined above, a dummy variable for ownership is uesd.This dummy variable takes the value of one if the firm belongs to the public sector and has value zero otherwise.

4. Empirical results

Both the Cobb-Douglas and the translog frontier production functions are estimated. The Cobb-Douglas versus the translog functional from was tested using the likelihood-ratio test statistic. The former model was rejected in the favor of the flexible translog functional from. Although, from a statistical point of view, Cobb-Douglas functional form is not preferred, but from an economic point view, it reveals more convicing results. This model presents reasonable elasticities with expected signs and returns to scale. Because of this advantage, the subsequent analysis will be based only on the Cobb-Dougals form. For a matter of comparison and the sensivity of the results the parameter estimates of both the Cobb-Douglas and the translog frontier production functions are reported in Table 1.

Parameters of the Cobb-Douglas functional form have the expected signs and are mostly significant. More specifically, all input elasticities are significantly different from zero at the 5 percent level. All of these elasticities are found to have the expected positive signs. The elasticity with respect labour, capital, material, and energy are 0.22 (-1.78), 0.13 (0.25), 0.61 (0.51), and 0.03 (0.17), respectively.

Input elasticities, for the translog form, calculated at mean of the data are given in parentheses. These are obtained from the logarithmic derivative of the production function measuring the percentage responsiveness of output due to a one percent increase in the respective inputs. Using the Cobb-Douglas model, the elasticity of material is estimated to be very high. This indicates that raw materials are more important than the other inputs in the production process.

The estimates of returns to scale (RTS), which is defined as the percentage change in output due to a proportional increase in the use of all inputs are 0.98. The returns to scale value is less than one indicating that the textile industries have a technology with decreasing returns to scale in Iran. Ownership coefficient is significant and positive, which indicates that the public firms are more technically inefficient than the private ones. The estimate for the coefficient associated with number of workers is negative and significant. This indicates that the firms having fewer labor are more technically efficient than those having more workers. The coefficient associated with the interaction of number of workers and ownership is negative. This implies that workers in public firms are more technically efficient than those in private ones. The estimate for the coefficient associated with number of workers is negative and significant. This indicates that the firms having fewer labor are more technically efficient than those having more workers. The coefficient associated with the interaction of number of workers and ownership is negative. This implies that workers in public firms are more technically efficient than those in private ones. However, this relationship is very weak and insignificant. The remaining two paramrters, $\sigma^2_s = \sigma^2_v + \sigma^2$ and $\nu = \sigma^2/\sigma^2_s$ are associated with the variances of the random variables, V_i and U_i. The estimate for ν is close to one, which indicates that the inefficiency effects are highly significant in the analysis of the value of output of the producers and the variance of the random errors is relatively small.

Generalized likelihood ratio tests of null hypotheses to indicate whether the inefficiency effects are absent or have simpler distributions are presented as follow(1).

NullHypothesis	Log(likelihood)	X^2statistic	Decision
$H_0: \nu = \delta_0 = \delta_{public} = \delta_{n.Labour^* owner} = 0$	-33.92	50.32	Reject H_0
$H_0: \nu = 0$	-30.74	43.98	Reject H_0
$H_0: \delta_{public} = \delta_{n.Labour^* owner} = 0$	-15.12	12.74	Reject H_0

Generalized likelihood-ratio test, in the case of the error compinent model.

The first null hypothesis, which specifies that the ineffinciency effects are absent from the model, is strongly rejected. The second null hypothesis considered in this table, H_0: $\nu = 0$, specifies that the ineficiency effects are absent from the model, is strongly rejected. If the parameter, ν, is zero, then the variance of the inefficiency effects is zero; thus the model reduces to a traditional mean response function in which characteristics variables; ownership, size (number of workers), and interaction of them are included in the production function. The third null hypothesis specifies that the inefficiency effects are not a linear function of firm characteristics. This null hypothesis is also rejected at the 5% level of significance. This indicates that the joint effects of these three explanatory variables on the inefficiencies of production is significant.

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1. The likelihood-ratio test staticts, {log[likelihood(H0)]-log[lokelihood(H1)]}, has approximately chi-square distribution with parameter equal to the number of parameters restrictef to be zero in the null hypothesis, H0, provided H0 is true.

The estimated technical efficiencies are reported in Table 2. The overall mean efficiency is 84% for both models. This means that, on average, the firms are operating relatively efficiently. Given the resources and inputs, the firms are producing outpt which is only 16% less than full potentional. The mean efficiencies for public and private firms are 84% and 86%.

Results show that the firms located in size one, the smallest size, are opening with less inefficiency probably due to the low capacity utilization of Iranian manufacturing industries.(1) In other words, the shortage of foreign exchange due to war (1979-1988), combined with difficulties in international trade relations, severely limited the accessibility of the essential raw materials. Thus, the larger firms had greater difficulties to obtain the raw materials, leading them to have more fixed costs due to having more equipment, machinery, and machine tools idled. Shortage of foreign exchange, probably, could not be solely responsible for the fall in capacity utilization. Overstaffing and the absence of experienced management in large-scale operations are two other reasons that might explain why the smallest size operated with less inefficiency. The frequency distribution of technical efficiency for both models is reported in Table 3.

Both models present that most of the textile companies are operating with tecnical efficiency of more than 85%. More specifically, more than 85 percent of private and 80 percent of public firms are operating at more then 80% technical efficiency. The correlation between technical efficiency and number of employees was found to be negative ndicating that those firms with more labour operate with more inefficiency.

5. Conclusion

This paper offers a preliminary analysis on the efficiency of 250 Iranian textile enterprises, privately and publicly owned, during 1995. The stochastic frontier production function is used for this purpose. Two alternative models are employed here to estimate and analyze the technical efficiency of production of firms. The maximum likelihood method is used to estimate parameters of models and predict efficiency for each enterprise. The important findings of this study are as follows:

First, the overall mean efficiency is 54% in both models indicating that, on average, there exists a potential for increase in output 16%.

Second, both models present public firms as operating less efficiently than private ones.

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1. There might be a greater difference in technical efficiency between the public and private firms because of underreported output by private producers seeking to lessen taxation.

Third, the results show that the smallest sized firms operate less inefficiently, probably, due to low capacity utilization within the textile industry.

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Table 1- Maximum - likelihood estimates parameters of stochastic frontier

Cobb-Douglas model			Translog model		
parameters	Est.	std.err.	parameters	Est.	std.err.
β_0	1.329*	0.173	β_0	1.293*	0.426
β_L	0.223*	0.017	β_L	0.206	0.286
β_K	0.132*	0.014	β_K	0.399*	0.053
β_M	0.611*	0.020	β_M	0.357*	0.107
β_E	0.028*	0.014	β_E	-0.066	0.096
δ_{public}	---	---	β_{LL}	0.146*	0.016
$\delta_{n.Labor}$	---	---	β_{KK}	0.098*	0.009
$\delta_{n.Labor^{*}owner}$	---	---	β_{MM}	0.221*	0.013
			β_{EE}	-0.129	0.012
Z variables			β_{LK}	-0.207	0.015
δ_0	-9.778*	3.777	β_{LM}	-0.266*	0.017
δ public	1.791*	0.824	β_{LE}	0.006	0.020
δn.Labor	-0.010*	0.001	β_{KM}	-0.198*	0.017
δn. Labor*owner	-0.004	0.001	β_{KE}	0.012	0.016
			β_{ME}	0.016	0.020
δ^2	1.381*	0.494	δ_{public}	---	---
ν	0.972*	0.011	$\delta_{n.Labor}$	---	---
μ	---		$\delta_{n.Labor^{*}owner}$	---	---

*** Significant at the 5% level of significance.**

Table 2- Mean Technical efficiency, cobb-Douglas and translog functional form.

	N	Efficiency	Std.dev	Min	Max	N	Efficiency	Std.dev	Min	Max
Cobb-Douglas:										
Private owner.	190	0.86	0.07	0.35	0.97	190	0.86	0.11	0.36	0.97
Public owner.	60	0.84	0.10	0.31	0.97	60	0.83	0.07	0.33	0.97
Smallest size	113	0.89	0.06	0.35	0.97	113	0.86	0.07	0.36	0.97
Small size	55	0.87	0.06	0.51	0.94	55	0.85	0.07	0.50	0.93
Medium size	31	0.86	0.07	0.61	0.98	31	0.84	0.08	0.55	0.97
Large size	21	0.83	0.09	0.55	0.96	21	0.85	0.09	0.51	0.96
Largest size	30	0.84	0.12	0.31	0.93	30	0.84	0.12	0.33	0.93
Mean	250	0.84	0.08	0.31	0.98	250	0.85	0.08	0.33	0.97

Table 3- Frequency distribution of technical efficiency by ownership coob-Douglas and translog functional form

Frequency			Mean efficiency		frequency		Mean efficiency	
Interval	private	public	private	public	private	public	private	public
Cobb-Douglas								
0.00-0.70	6	4	0.60	0.54	7	4	0.60	0.50
0.70-0.75	2	2	0.74	0.74	3	3	0.74	0.74
0.75-0.80	8	1	0.78	0.77	9	3	0.78	0.77
0.80-0.85	8	4	0.82	0.83	25	18	0.84	0.83
0.85-0.90	97	36	0.88	0.88	111	22	0.88	0.87
0.90-0.95	65	10	0.92	0.92	34	8	0.92	0.92
0.95-1.00	4	3	0.96	0.96	1	2	0.96	0.96
mean	---	---	0.88	0.86	---	---	0.86	0.83