

12-1-2004

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Recommended Citation

Walujadi, D. (2004). Age, Export Orientation and Technical Efficiency: Evidence From Garment Firms in DKI Jakarta. *Makara Human Behavior Studies in Asia*, 8(3), 97-104. <https://doi.org/10.7454/mssh.v8i3.97>

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AGE, EXPORT ORIENTATION AND TECHNICAL EFFICIENCY: EVIDENCE FROM GARMENT FIRMS IN DKI JAKARTA

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Abstrak

Dalam studi ini, efisiensi teknis dari industri garmen di DKI Jakarta diperkirakan dengan mengakomodasi terjadinya efek ketidakefisienan teknis dalam suatu model *stochastic frontier* fungsi produksi. Tujuannya adalah untuk memperkirakan efisiensi teknis dari perusahaan sekaligus menjelaskan sumber-sumber penyebab ketidakefisienan dalam konteks kebijakan ekonomi makro di Indonesia. Hasil empiris menampilkan beberapa gambaran yang menarik dari kinerja ekonomi perusahaan garmen dalam kaitan dengan karakteristik spesifik yang diperkirakan mempengaruhinya. Dalam penelitian ini terbukti fungsi produksi Cobb-Douglas tidak representatif dalam menjelaskan kasus efisiensi teknis di DKI Jakarta, tetapi sumber-sumber ketidakefisienan dan adanya perubahan teknis dapat dibuktikan.

Abstract

In this paper, the technical efficiency of garment firms in DKI Jakarta is estimated by incorporating a model for the technical inefficiency effects in the stochastic frontier production function. The aims are to estimate both the technical efficiency of the firms and the sources of technical inefficiency within the context of Indonesia's macro-economic policy. The empirical results point a number of noteworthy features of the economic performance of firms in relation with some specific characteristics. It is found in the study that the Cobb Douglas functional form was not adequate, but the sources of technical inefficiency were found and technical change was present.

Keywords: technical efficiency, stochastic frontier production function, panel data, garment firm

1. Introduction

There are some reasons why analysis of garment firms in DKI Jakarta is challenging and important for us. First, from a policy point of view, it is of interest to distinguish the effects of some variables in mean efficiency levels and to determine whether these variables reduced or increased the technical efficiency, based on the inefficiency models applied. Second, as is presented in Table 1, the 1995 annual manufacturing survey results provides clear evidence that DKI Jakarta is the second-dominant garment-producing region after Province of West Java, with respect to three different criteria. It accounts for about 29.6 per cent of output, 27.8 per cent of employment, and 33.1 per cent of all firms in Indonesia. Third, the fact that the larger-sized garment firms in Jakarta are more capital-intensive, have better access to factor inputs and new technology and have a more export-orientated production compared

with other regions in Indonesia is another reason why the study is important.

The present study considers the analysis of data for the years, 1990 to 1995. A lot of developments have taken place during that time, since firms entered the international market in the 1970s. It was the previous objective of the study to cover the time period of both before (from 1980 to 1985) and after the liberalization policies (1986 to 1995). However, given the dramatic increase in the number of garment firms during 1985 to 1990, the study focuses on the period, 1990 to 1995. Further, it is during the period from 1990 to 1995 that the export earnings from Indonesia's garment industry remained stagnant, and showed a decline in 1993. It is believed that the present study using DKI Jakarta case may provide insights into the Indonesian garment industry that may prove useful from a policy perspective.

Table 1: Regional distribution of output, employment and number of firms, 1995 (percentages of total)

Region/Province	Output	Employment	No. of Firms
Java	95.5	94.0	85.4
Jakarta	29.6	27.8	33.1
West Java	56.3	52.4	24.0
Central Java	7.1	8.8	18.1
East Java	2.5	5.0	10.2
Outer Islands	4.5	6.0	14.6
Indonesia	100.0	100.0	100.0

Source: BPS, Annual Manufacturing Survey 1995, calculations by the author

The study estimates the technical efficiencies of garment firms in DKI Jakarta by incorporating a model for the technical inefficiency effects in the stochastic frontier production function. In the second section, the empirical model for the technical inefficiency effects in the stochastic frontier production function is presented. In this section, the preferred frontier model is determined. Generalised likelihood-ratio tests are conducted to obtain the preferred model for DKI Jakarta. The analyses aim to determine the factors affecting the efficiency levels among garment firms in DKI Jakarta. The third section describes the relationship between firm-level technical efficiency with other possible sources of inefficiency, such as size and age of the firms, export shares, and proportion of domestic to total cost of raw materials during the period of observation. The fourth section closes with a summary and conclusions.

2. The Model and the Data Used

This study uses the data on manufacturing firms in the garment industry collected as a part of annual surveys of manufacturing industry. Though referred to as annual surveys, they are based on a complete enumeration of all the firms in the industry. These surveys are conducted by Indonesia's Central Board of Statistics (Badan Pusat Statistik or BPS) on an annual basis.

Being a complete enumeration of the medium- and large-scale firms, the annual Indonesian manufacturing surveys provide better and more comprehensive statistical information. Therefore, the survey results are expected to be more precise than those based on other surveys that use sampling methodology. The study, involves the six years of panel data from 1990 to 1995 for the medium and large-scale garment firms in DKI Jakarta. The study also has adopted the stochastic frontier production function model, proposed by Battese and Coelli (1995), in the estimation of production frontiers and the measurement of technical efficiency. It is postulated that technical inefficiencies in production by firms in the garment industry exist and that they are a function of the values of several observable explanatory variables.

The stochastic frontier production function, as it is presented in equation 1, is used in this study.

$$\lambda n Y_{it} = \beta_0 + \beta_0^* D_{it} + \sum_{j=1}^5 \beta_j x_{jit} + \sum_{j \leq k=1}^5 \sum_{k=1}^5 \beta_{jk} x_{jit} x_{kit} + V_{it} - U_{it},$$

$$i=1,2,\dots,N; t=1,2,\dots,T \quad (1).$$

where $\lambda n Y_{it}$ represents the natural logarithm of the total value of manufacturing output for the i -th firm in the combined data set for all regions in the t -th year;

D is the dummy variable for the actual annual value of investment, which has value one if the firms had an investment, zero, otherwise (the subscripts, i and t , are omitted for simplicity of presentation);

x_1 represents the total value of operating costs of capital (in thousands of Rupiahs);

x_2 represents the total number of paid labourers;

x_3 represents the total value of costs of raw materials purchased by the firm (in thousands of Rupiahs);

x_4 represents the maximum of the total amount of actual investments by the firm (in thousands of Rupiahs) and the value of $1-D$ for the firm; and

x_5 is the time variable, where $x_5=1,2,\dots,6$ for the years, 1990, 1991,..., 1995 respectively;

the V_{it} s are assumed to be independent and identically distributed as normal random variables with mean zero and variance, σ_v^2 , independent of the U_{it} s. However,

the empirical model for the technical inefficiency effects, the U_{it} s, in the stochastic frontier production function are assumed to be independently distributed such that U_{it} is obtained by the truncation (at zero) of the Normal distribution $N(\mu_{it}, \sigma^2)$,

where,

$$\mu_{it} = \delta_0 + \delta_1 Age_{it} + \delta_2 Size_{it} + \delta_3 Export_{it} + \delta_4 Domestic_{it} + \delta_5 Re Form_{it} + \delta_6 Year_{it} \quad (2)$$

where,

Age_{it} represents the age of the firm (years since establishment);

$Size_{it}$ represents the natural logarithm of total number of paid labourers;

$Export_{it}$ is the percentage of production being exported;

$Domestic_{it}$ is the percentage of total cost of domestic raw materials to the total cost of all raw materials;

$Reform_{it}$ is dummy variable for economic reforms having value one for the year 1993 to 1995, zero for the year 1990 to 1992.

$Year_{it}$ is the time variable, where $Year_{it}=x_5$

3. Empirical Results

3.1. Estimation of the Frontier and Testing of Hypotheses

Various null hypotheses concerning the above stochastic frontier production function model are applied to determine the preferred models for this study. The null hypotheses that are considered to find the appropriate model are discussed below.

The first null hypothesis, $H_0: \beta_{jk} = 0, j \leq k = 1, 2, \dots, 5$ specifies that the second-order coefficient in the translog production function are zero and so the Cobb-Douglas frontier is an adequate representation for garment firms. Because the Cobb-Douglas is a much simpler function than the translog, it is of particular interest to test whether the Cobb-Douglas function provides an adequate representation of the data, given the specifications of the translog stochastic frontier with the model for the technical inefficiency effects.

The second null hypothesis, $H_0: \gamma = \delta_0 = \delta_1 = \dots = \delta_6 = 0$, where $\gamma = \sigma^2 / (\sigma_v^2 + \sigma^2)$, specifies that the garment firms are fully technically efficient in this study.

The third null hypothesis in this study, $H_0: \beta_5 = \beta_{j5} = 0, i = 1, \dots, 5$, specifies that there is no technical change in the stochastic frontier model. In the stochastic frontier, the distributional assumptions of the inefficiency effects permit the identification and estimation of technical change and the time-varying behaviour of the inefficiency effects, in addition to the intercept parameters, β_0 , and δ_0 , in the stochastic frontier and the inefficiency model. Neutral technical change is present if the coefficient of the interactions between year of observation and the input variables are zero, i.e., $\beta_{i5} = 0, i = 1, \dots, 4$

In the present study, the two variables, labour and time, are used both in the stochastic frontier and the inefficiency model. In addition to its accounting for technical change in the production function, in the inefficiency model (2) the time variable specifies that the inefficiency effects may change linearly over time. The fourth null hypothesis, that the technical inefficiency effects are not influenced by size of firm

and time as measured by labour, is expressed by $H_0: \delta_2 = \delta_6 = 0$.

Finally, the fifth null hypothesis states that the technical inefficiency effects are not influenced by the presence of the firm size in the inefficiency model. This null hypothesis is expressed by $H_0: \delta_2 = 0$. If this hypothesis is true then the frontier model is a *neutral* stochastic frontier, for which the calculation of the elasticity of labour does not involve the elasticity of technical efficiency as outlined in Huang and Liu (1994) and Battese and Broca (1997). A summary of the formal tests of these hypotheses is given in Table 2, below.

The first null hypothesis, that the Cobb-Douglas frontier is adequately representative for garment firms, is strongly rejected by the obtained. The second null hypothesis, that the technical inefficiency effects are not present is also rejected. The third null hypothesis that there is no technical change in garment industry, is also strongly rejected. The fourth null hypothesis, specifies that the coefficient size of the firm and time in the inefficiency model is accepted. This means that these explanatory variables have no effects on the technical inefficiencies. Finally, the fifth null hypothesis that the technical inefficiency effects are not influenced by the size of the firms is accepted. Based on the results of these statistical tests, further analyses are presented using the preferred stochastic frontier model.

3.2. Parameter of Maximum-likelihood Estimates and Its Interpretation

Table 3 presents the maximum-likelihood estimates of the above translog production function from 1990 to 1995. These estimates are presented with the estimated standard errors of the maximum-likelihood estimators, which are given to two significant digits. The coefficients vary in terms of levels of significance.

Several comments should be added concerning the parameters of the maximum likelihood estimates, in particular for labour and cost of raw materials which remained as two main components of inputs in the garment production. The sensitivity of output with respect to labour is positively related to labour (β_{22}). Thus implying that, labour is not price responsive for DKI Jakarta. The sensitivity of output with respect to labour is positively related to cost of capital (β_{12}). β_{12} is positive but it is not statistically significant. The parameters, β_{25} , suggest the technical change biases related to labour. The positive signs shows that the usage of labour increases over time. The sensitivity of output with respect to labour in relation to cost of materials (β_{23}) has a negative sign and is statistically significant, imply that labour is responsive to increase in raw materials.

The sensitivity of output with respect to cost of raw materials is positively related to cost of raw materials (β_{33}) and highly significant, thus implies that cost raw materials is not price responsive. However, the inverse relationship occurred for the sensitivity of output with respect to cost of raw materials related to investments and is significant. The parameter β_{35} which represents the change of factor share with respect to time is negative and highly significant. Thus implying that, the expenses on raw material decrease over time.

The important estimate which is probably the more relevant in context of this efficiency study is the variance ratio, γ . The variance ratio is very small (0.016). However, as indicated in the discussion of Table 1, the likelihood-ratio tests indicate that the technical inefficiency effect is statistically significant. The t-test is critically dependent on the estimated standard errors of the maximum likelihood estimators which often are quite large. The likelihood-ratio test is preferred because they only depend on the values of the likelihood function under the null and alternative hypotheses.

3.3 Sources of Technical Inefficiency

The estimated coefficients in the technical inefficiency model are of particular interest to this study. This study examines several hypotheses drawn from the literature on micro-economic analysis, industrial development and

policies in developing countries, in so far as they are relevant to the DKI Jakarta case and possibly influence efficiency of firms. This section, based on the results of the estimation of the inefficiency model in the stochastic

frontier, as shown in Table 3, quantitatively demonstrates the importance of the relationship between the characteristics of firms and technical inefficiency.

The evidence presented in Table 3 on the age of firms and their technical inefficiency is not self explanatory. The estimate for the age coefficient is negative but insignificant. Thus suggesting that, older firms are less inefficient than the younger ones. Table 3 also shows that, the coefficient related to the percentage of production being exported is negative, but is not statistically significant, according to simple t-tests.

The estimate for the coefficient of the proportion of domestic raw materials is positive. The result indicates that as the proportion of domestic raw materials increases the technical inefficiency of garment producer tends to increase, but the increase is quite small. One of the possible reasons is the presence of large-scale garment firms which using high-quality imported raw materials. These firms which have franchised or product sharing agreements with their principal, could be strong enough to affect the local availability effect on the technical inefficiency of firms.

The coefficient of the economic reforms dummy variable in Table 3 shows that the technical inefficiency of the garment firms tended to decline after the introduction of economic reforms in 1992, but insignificant.

Apart from the disadvantages, such as a possible domination of foreign share on the domestic firms, there have been several advantages of foreign direct investment (FDI) that can be obtained by domestic

Table 2: Likelihood-ratio tests of hypotheses for parameters of the stochastic frontier production functions technical inefficiency effects, the garment industry in DKI Jakarta, 1990-1995

Assumption	Null Hypothesis	Log-likelihood	LR statistic	Critical Value	Decision
Translog Cobb-Douglas	$H_0: \beta_{ij} = 0, i \leq j = 1, \dots, 5$	-1097.59	1203.29	25.0	Reject H_0
Translog (no technical inefficient)	$H_0: \gamma = \delta_0 = \dots = \delta_6 = 0$	-1110.06	18.77	14.85*	Reject H_0
Translog (no technical change)	$H_0: \beta_5 = \beta_{15} = 0, i = 1, \dots, 5$	-1126.92	52.50	12.59	Reject H_0
Translog (no size and time effects on technical inefficiency)	$H_0: \delta_3 = \delta_6 = 0$	-1098.41	1.65	5.99	Accept H_0
Translog (no size effect on technical inefficiency)	$H_0: \delta_2 = 0$	-1098.39	1.61	3.84	Accept H_0

Source: BPS, Indonesia's Annual Manufacturing Survey 1990-1995, calculations of log-likelihood values based on the FRONTIER 4.1 program.

* The critical values for the test involving $\gamma = 0$ are obtained from Table 1 of Kodde and Palm (1986) where the degrees of freedom are $q+1$, where q is the number of parameters which are specified to be zero which are not boundary values.

garment firms, such as increased penetration in foreign markets and enhancement of the efficiency in manufacturing through introduction of new technology. It might be possible that the large-scale garment firms in these regions optimised the opportunities that government offered in regulating the economy (in this case through the new investment regulation in 1992) and in anticipating for a greater consolidation of manufacturing industry everywhere. Thus, by the new economic regulations, the domestic firms could get benefit from the recent technological innovations through the availability of FDI, which nowadays has been the main force leading to the cross-border cooperation among firms.

3.4. The Output Elasticities

The evidence also indicates that the output sensitivity with respect to an increase in long-term investment

(expenditures on plant and equipment) is positive, but statistically insignificant.

The output elasticities with respect to the operating cost of capital, labour, cost of raw materials and investment are estimated using the translog stochastic frontier production function model. These elasticities depend on the levels of all inputs and estimates are presented in Table 4 using the average values of the inputs. Elasticity coefficients for operating cost of capital, labour, and raw materials are positive and significant at the one per cent level, implying that marginal productivity of each input is positive. For instance, if the cost of raw materials increases by one per cent, holding all other inputs constant, then the output is estimated to increase by 0.667 per cent in Jakarta.

The output elasticity with respect to the operating cost of capital is 0.101. The output elasticity with respect to

Table 3. The maximum-likelihood estimates of the translog stochastic frontier production function given the technical inefficiency effects model for the DKI Jakarta garment industry, 1990-1995

Variable	Parameter	Value
A. Stochastic Frontier		
Constant	β_0	7.40 (0.41)
Investment dummy	β_0^*	-0.23 (0.22)
Operating cost of capital	β_1	0.406 (0.089)
Labour	β_2	1.17 (0.12)
Cost of raw materials	β_3	-0.543 (0.053)
Investment	β_4	-0.023 (0.041)
Year	β_5	-0.032 (0.049)
(Operating cost of capital) ²	β_{11}	-0.0039 (0.0080)
(Labour) ²	β_{22}	0.061 (0.015)
(Cost of raw materials) ²	β_{33}	0.0777 (0.0022)
(Investment) ²	β_{44}	0.0002 (0.0013)
(Year) ²	β_{55}	0.0221 (0.0033)
Operating cost of capital x Labour	β_{12}	0.017 (0.017)
Operating cost of capital x Cost of raw materials	β_{13}	-0.0245 (0.0076)
Operating cost of capital x Investment	β_{14}	0.0023 (0.0019)

Lanjutan Tabel 3.

Variable	Parameter	Value
Labour x Cost of raw materials	β_{23}	-0.1259 (0.0098)
Labour x Investment	β_{24}	-0.0087 (0.0026)
Labour x Year	β_{25}	0.0105 (0.0081)
Cost of raw materials x Investment	β_{34}	0.0046 (0.0012)
Cost of raw materials x Year	β_{35}	-0.0118 (0.0042)
Investment x Year	β_{45}	-0.0004 (0.0010)
B. Inefficiency Model		
Constant	δ_0	0.238 (0.084)
Age	δ_1	-0.0001 (0.0020)
Labour	δ_2	-
Percentage of production being exported	δ_3	-0.00056 (0.00034)
Proportion of domestic to total cost of raw materials	δ_4	0.00028 (0.00059)
Economic reforms dummy	δ_5	-0.18 (0.12)
Year	δ_6	-
C. Variance Parameters		
	σ^2	0.1507 (0.0050)
	γ	0.016 (0.037)
D. Log likelihood function		
		-1098.41

Source: as Table 2. Values are estimated using the maximum-likelihood technique for the model specified in equation 1 and 2 by using the FRONTIER 4.1 program written by Coelli (1996). Standard errors are shown in parentheses.

Table 4: Output Elasticities

Input variable	Value
Operating cost of capital	0.101 (0.025)
Labour	0.238 (0.033)
Cost of raw materials	0.667 (0.017)
Investment	0.019 (0.028)

Source: As for Table 2 Figures in parentheses are standard errors of estimates.

labour is 0.238. The partial output elasticity for cost of raw materials is somewhat higher (0.667).

The elasticity coefficient is less than unity for each input. This elasticity coefficient can be interpreted as the ratio of marginal to average productivity. In the short-run, the results can be indicated that garment firms are subject to diminishing marginal productivity with respect to each input. While in the long run, the sum of all elasticities with respect to its inputs (the returns to scale), is found mildly increasing (1.025). These findings, that the garment firms were characterised by constant or moderately increasing returns to scale, mean that there is no clear evidence of size problems in these medium and large-scale garment firms, as is often

stimulated public discussion on the small or large manufacturing issue.

4. Conclusions

The garment industry's impressive growth in the last decade has often been attributed to its emphasis on exports or the ability to enter the international market place. The important role of exports in providing firms with a means of acquiring technology from abroad, in addition to technology licensing and foreign capital, have also been emphasised in this achievement. In addition to other firm's specific characteristics, the present study uses the variables of export intensity, government policies on FDI as factors affecting firm performance, and tries to measure their influence on the technical inefficiency of garment firms.

The empirical results point a number of noteworthy features of the economic performance of firms in relation with some specific characteristics. First, The Cobb-Douglas functional form was not adequate, but the technical efficiency effects were significant and technical change was present.

Second, the hypothesis that technical inefficiency effects are not influenced by the size of firms was accepted and there was also no time change in the technical inefficiency.

Third, the signs of the coefficients of the various variables in the translog stochastic frontier are as expected. The positive coefficients of all the output elasticity measures, being significant at the one per cent level, confirm the possibility to increase output by increasing the application of inputs. The output elasticities of labour in DKI Jakarta estimated to be 0.24, means that, if labour is increased by 10 per cent holding all other inputs constant, output can be increased by about 2.0 per cent.

Fourth, whether it is possible to increase the output without having to increase the levels of any input, may be answered by the positive signs of the investment coefficient. These positive sign indicating that DKI Jakarta is likely to experience technological progress or an upward shift in the production frontier. The technical progress caused by new investment is 2.0 per cent and this investment coefficient is insignificant.

Fifth, the results show that the age coefficients is negative and insignificant, which therefore would indicate that the older firms are more efficient than the younger ones.

Sixth, further investigation shows that the coefficient related to the percentage of production being exported is

negative. Thus, implying that firms with a higher percentage of production for export are more efficient than those firms which export a lower percentage of their output. The result is consistent with the findings of Chen and Tang (1987) and Hill and Kalirajan (1993).

Seventh, the evidence shows that firms with a higher proportion of imported raw materials tend to be more efficient than those with smaller proportions of imported raw materials. The coefficient of proportion of domestic to total cost of raw materials is positive and but insignificant.

Eighth, the evidence indicates that the technical inefficiency of the garment firms tended to decline after the introduction of economic reforms in 1992. The negative estimate reflects the large benefits that DKI Jakarta obtained from the economic reforms. The result indicates that the critical role of the firm to obtain international knowledge by acquiring technology from abroad through exports, technology licensing and foreign capital may have higher pay offs by its higher achievement in economic performance.

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