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Productivity analysis for Vietnam's textile and garment industry

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Abstract

The study uses firm-level panel data to study the technical efficiency performance of Vietnam's textile and garment firms in the period 1997-2000, as well as its determinants. The model used is that of Battese and Coelli [1995]. The average estimated technical efficiency of the two subsectors is relatively high. In the textile subsector, medium-old, South-based, private, export-oriented, and highly equipped firms are found to be more technically efficient than those with differing characteristics. In the garment subsector, large or old-medium, South-based, and high external capital firms have higher technical efficiency. Meanwhile, small, old, and highly equipped firms have lower technical efficiency than firms with other characteristics. The total factor productivity (TFP) picture of the textile subsector is mixed, whereas the TFP growth of the garment subsector is positive, although this growth decreases.

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1. Introduction

The 1990s witnessed the impressive performance of the Vietnam textile and garment (T&G) industry. Quickly recovering from great difficulties caused by the collapse of the former Soviet Union and Eastern European socialist countries and

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the resulting loss of the CMEA (Council for Mutual Economic Assistance) market, the Vietnam T&G industry managed to develop with an average growth rate of 10.6 percent per annum, constituting 7.5 percent of the overall gross domestic product (GDP) in the past years [GSO 2003]. The sector has consistently featured on the list of top exporting industries. In 2004, the export value of the T&G industry reached approximately US$ 4.3 billion, thus becoming the second-largest earner of badly needed foreign exchange in Vietnam [*Vietnam Economic Times* 2005].

Equally important, the industry is highly labor intensive by nature, generating the largest number of jobs among manufacturing industries—comprising 22.2 percent of the total employment in the manufacturing sector [Vietnam Living Standards Survey 1997/1998]. The T&G sector has therefore been regarded as an important and strategic industry in solving the acute problem of unemployment and poverty, by exploiting Vietnam's comparative advantage in labor-intensive production. Although these unprecedented achievements are undeniable, the T&G industry is not without problems regarding productivity, which could threaten its sustainable development. This has naturally aroused interest of researchers, spurring them to do careful studies on efficiency and productivity, and make well-founded policy recommendations toward improvements in the industry's performance.

This research is made in an effort to continue upgrade and correct the shortcomings of the previous Vietnam Economic and Environmental Management (VEEM) report [IMPR 2001b] in productivity analysis for the T&G industry. First, the use of the total wage bill as a measure of labor input may cause problems of identity and non-absoluteness in controlling the differences in both production function and technical inefficiency effects, which may lead to bias in the estimate results. Second, the assumption of all firms' minimizing costs and maximizing profit, which is inherent in the Tornquist index number approach applied, may be a constraint to the analysis. Third, the analysis does not take advantage of properties of unbalanced panel data available. Fourth, the results of total factor productivity (TFP) growth and technical progress (TP) could be considerably improved if better deflators can be calculated. The methodology applied in this study will partly improve the productivity analysis by obtaining better deflators and using the stochastic frontier method to directly calculate Malmquist TFP index and its components.

To fulfill the above objectives, the rest of the study is organized as follows: section 2 briefly describes the methodology that will be used for the subsequent empirical analysis. Based on the regression results and estimates of indices, section 3 gives a detailed picture of the technical efficiency performance of the textile and garment subsectors and the determinants of such technical efficiency. Section 4 will give the whole content growth pattern of TFP over the years. The final section presents the main findings and suggestions for further research.

2. Methodology

This section presents the methodological framework that will be used for the subsequent empirical analysis. A brief discussion of sources of output growth, which include input growth and TFP change, will be presented in the beginning. Next, the section mentions the Malmquist TFP index that will be applied in the study. It then discusses the stochastic frontier method to estimate the Malmquist technical efficiency change (TEC), TP change, and TFP growth. Some other methodological issues will be shown in this section.

2. 1. Source of output growth and the Malmquist index

On the supply side, any output growth is determined by the expansion of productive resources and by the improvement in their use. The latter is expressed through the TFP concept, which measures joint productivity of all inputs used in combination to produce some goods and/or services. TFP change, as mentioned earlier, can be in turn broken down into TEC and TP. The concept of TFP is closely related to disembodied technological change in that it does not increase the productivity of a particular input but rather that of all input jointly.

To have clearer picture, a production function is specified as

$$Q(t) = F\left[Z(t), t\right] \cdot e^{u(t)} \tag{1}$$

where

$Q(t)$ is the observed output level at time *t*,

$Z(t)$ is the set of inputs used at time *t*,

$F\left[Z(t), t\right]$ is potential output at best practice level at time *t*, and

$eu(t)$ is the level of technical efficiency with $u(t) \leq 0$.

By taking the derivative with respect to time (*t*) and dividing both sides of the equation by $Q(t), (1)$ can be rewritten as

$$\frac{\dot{Q}(t)}{Q(t)} = \frac{F_z z}{F}\frac{\dot{Z}}{Z} + \frac{F_t}{F} + \dot{u} \tag{1'}$$

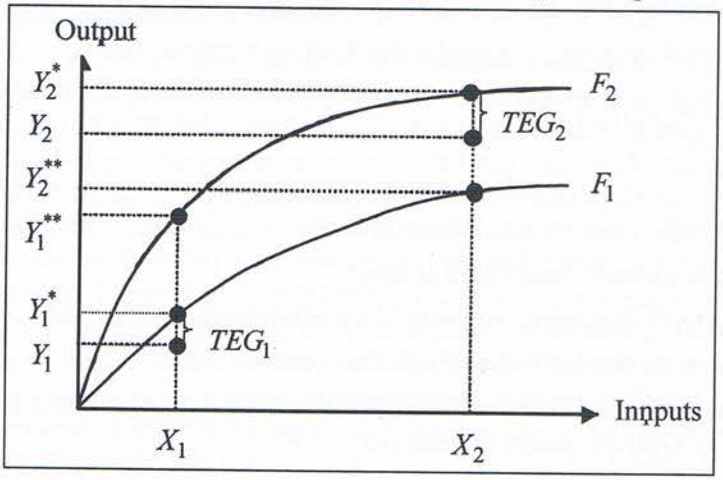
where $F_z z/F$ and F_t/F are the output elasticity of $F\left(Z(t), t\right)$ with respect to inputs $Z(t)$ and time *t*, respectively. $\dot{U}(t)$ represents the TEC over time at point *t*.

Thus, the changes in output can be decomposed into three components: the first term of $(1')$ reflects the output change caused by input change or input accumulation; the second term represents the rate of TP; and the third one, the TEC.

By definition, TFP change reflects the variation of output that cannot be explained by changes in inputs; therefore, it combines TP and TEC, which are captured by the last two terms of $(1')$.

The following figure helps visualize how a change in output can be broken down into the aforementioned components. In the output-input space, the firm has the production frontiers F_1 and F_2 for years 1 and 2, respectively. The firm is said to be technically efficient if output is produced at the frontier level, e.g., Y_1^* in period 1 and Y_2^* in period 2. Otherwise, the firm is technically inefficient; for example, if realized outputs are Y_1 in period 1 and Y_2 in period 2, both being lower than the efficient levels, i.e., $Y_1 < Y_1^*$ and $Y_2 < Y_2^*$. In Figure 1, technical inefficiencies (or technical efficiency gaps) are abbreviated as TEG_1 for period 1 and TEG_2 for period 2, respectively. The change in technical efficiency over time is the difference between TEG_1 and TEG_2. TP is measured by the distance between production frontier F2 and frontier F1, i.e., $\left(Y_1^{**} - Y_1^*\right)$ at the input level of X_1 or $\left(Y_2^* - Y_2^{**}\right)$ at the input level of X_2.

Figure 1. Output growth decomposition (output and input in logarithmic scale)



Therefore the total output growth, $(Y_2 - Y_1)$, can be decomposed into input growth, TP and TEC, as follows:

$$
\begin{aligned}
Y_2 - Y_1 &= \left[Y_1^* - Y_1\right] + \left[Y_1^{**} - Y_1^*\right] + \left[Y_2 - Y_1^{**}\right] \\
&= \left[Y_1^* - Y_1\right] + \left[Y_1^{**} - Y_1^*\right] + \left[Y_2 - Y_1^{**}\right] + \left[Y_2^* - Y_2^*\right] \\
&= \left[Y_1^* - Y_1\right] + \left[Y_1^{**} - Y_1^*\right] - \left[Y_2^* - Y_2^*\right] + \left[Y_2^* - Y_1^{**}\right] \\
&= \left\{\left[Y_1^* - Y_1\right] - \left[Y_2^* - Y_2\right]\right\} + \left[Y_1^{**} - Y_1^*\right] + \left[Y_2^* - Y_1^{**}\right]
\end{aligned}
$$

Thus:

$$Y_2 - Y_1 = -\{TEG_2 - TEG_1\} + TC + \Delta YX$$

where

$$Y_2 - Y_1 = \text{output growth}$$
$$(TEG_2 - TEG_1) = \text{output growth due to TEC}$$
$$TC = \text{output growth due to TP}$$
$$\Delta YX = \text{output growth due to input growth}$$

The sum of the first two terms in $(1'')$ is TFP change. In other words, TFP change consists of change in technical efficiency and TP. In the short run, TFP change may be induced by an improvement in technical efficiency, which allows firms to increase outputs from a fixed set of inputs under a given technology. Technical efficiency thus provides a measure of TFP gap for an individual firm relative to the production frontier, which describes the best available technique. In the long run, however, the frontier can itself shift with TP, leading to aggregate productivity growth.

The distinction between TEC and TP is important in the sense that different policy implications may be made from the same TFP change. For example, if the TEC effect is substantial and dominates the TP effect, policies should be focused on providing incentives and the appropriate business environment to induce and enable firms to catch up with the best practice. On the other hand, if the majority of firms are located in a close distance from the production frontier, priority should be given to policy measures that encourage TP. These two sets of policies may be quite different from each other.

There are some ways to compute the TFP index and its decomposition. One commonly used, traditional method is the Divisia index, which is based either on cost shares or on input shares in total revenue. However, this method requires accepting the restrictive assumption that all firms minimize cost and maximize profit. One way to get rid of this issue is to apply the Malmquist TFP index. Furthermore, this index number method can take advantage of (balanced and unbalanced) panel data used in the analysis without price data.

The Malmquist productivity indices were first suggested by Caves, Christensen, and Diewet [1982] and further developed by Fare et al. [1989]. This index is defined using Shephard's distance functions, which describe multi-input and multi-output production technology without the requirement to specify a behavioral objective (such as cost minimization or profit maximization). Fare, Grosskopf, and Lovell [1994] specified the Malmquist (output-oriented) TFP change index between period s (the base period) and period t as follows:

$$mo(ys, xs, yt, xt) = \left[\left(dos(yt, xt)/dos(ys, xs)\right) \cdot \left(dot(yt, xt)/dot(ys, xs)\right)\right]^{1/2} \quad (2)$$

where $dos(yt,xt)$ represents the distance from the period t observation to the period s technology. The productivity index may be rewritten in one equivalent way as follows:

$$mo(ys,xs,yt,xt) = [dot(yt,xt)/dos(ys,xs)] \cdot \\ [(dos(yt,xt)/dot(yt,xt)) \cdot (dos(ys,xs)/dot(ys,xs))]^{1/2} \tag{3}$$

The first term measures the change in the output-oriented measure of technical efficiency between periods s and t (catching up to the frontier), whereas another provides a measure of technological change (innovation). It is the geometric mean of the shift in frontier between periods s and t, evaluated at xt and at xs.

2.2. Stochastic production frontier method

To estimate the Malmquist indices, there are some options. The Malmquist TFP index can be calculated using nonparametric methods. However, this approach assumes constant returns to scale and does not allow for measurement error and does not provide statistical properties. The study will use the stochastic frontier method (econometric method) because it may produce TE change, TP change, and TFP change directly and take advantage of unbalanced panel data. However, since the panel is too short and small, the random or fixed effects approach is not chosen.

The econometric way is to follow Battese and Coelli's [1995] stochastic frontier production model. Accordingly, the production technology of a firm may be specified as follows:

$$\ln Y_{it} = \beta_0 + f(\ln(X_{it}),t,\beta) + (V_{it} - U_{it})(4) \quad i=1,\ldots,N, \quad t=1,\ldots,T \tag{4}$$

where

Y_{it} = the production output of the i^{th} firm in the t^{th} time period

X_{it} = vector of inputs

β = vector of parameters to be estimated

V_{it} = random variables, which are assumed to be *i.i.d.* $N(0,\sigma v^2)$ ("white noise")

U_{it} = one-sided non-negative random variables called technical inneficiency effects, which is assumed to be *i.i.d* as truncations at zero of the $N(mit,\sigma U^2)$ distribution, where

$$mit = Z_{it}\delta \tag{5}$$

Z_{it} is a $px1$ vector of variables that may affect the firm-specific efficiency; δ is a $1xp$ vector of parameters to be estimated.

Equations (4) and (5) are denoted as frontier and inefficiency equations, respectively. They can be estimated in ML approach with the help of software FRONTIER 4.1 by Tim Coelli [1996]. Technical efficiency is defined as

$$TE = \frac{Y_{it}^{actual}}{Y_{it}^{potential}} = \frac{f(X_{it},\beta,t)e^{v_{it}-u_{it}}}{f(X_{it},\beta,t)e^{v_{it}}} = e^{-u_{it}}$$

By observing that $dot(x_{it},y_{it}) = TE_{it}$ and $dos(x_{is},y_{is}) = TE_{is}$, the efficiency change can be derived as $TE\ change = TE_{it}/TE_{is}$, which may be directly compared to the first term in equation (3). The technological change index between adjacent periods s and t, as expressed by a geometric mean $\left[\left(1+\partial f(x_{is},s,\beta)/\delta_s\right)^{*}\left(1+\partial f(x_{it},t,\beta)/\delta_t\right)\right]^{1/2}$ may be directly compared to the second term in equation (3). The Malmquist TFP index can be derived as the product of these two indices.

To make the frontier model operational for an econometric analysis, we need an explicit functional form of the production function. To get started, the transcendental logarithmic (translog) function is used, which can be considered the second order approximation of any function. However, to get rid of the burden of this form under small numbers of observations in the dataset, other forms of the production function could be used. The explicit form of the translog form of the production function is as follows:

$$\begin{aligned}\ln(Y_{it}) = \beta_0 &+ \beta_K \ln(K_{it}) + \beta_L \ln(L_{it}) + \beta_M \ln(M_{it}) + \beta_{KK}\left[\ln(K_{it})\right]^2 + \\ &\beta_{LL}\left[\ln(L_{it})\right]^2 + \beta_{MM}\left[\ln(M_{it})\right]^2 + \beta_{KL}\ln(K_{it})\ln(L_{it}) + \\ &\beta_{LM}\ln(L_{it})\ln(M_{it}) + \beta_{MK}\ln(M_{it})\ln(K_{it}) + \beta_{K_t}\ln(K_{it})t + \\ &\beta_{L_t}\ln(L_{it})t + \beta_{M_t}\ln(M_{it})t + \beta_t t + \beta_{tt}t^2 + V_{it} - U_{it}; \qquad (6) \\ &i = 1,2,\ldots,N; \quad t = 1,2,\ldots,T\end{aligned}$$

where Y_{it} is output (or value added) of firm i produced in year t; K_{it}, L_{it}, M_{it} are capital, labor, and intermediate inputs of firm i in year t. For empirical analysis of the T&G industry, value-added production function may be a good option for consideration because it may avoid difficulties associated with modeling the distinct technologies of coexisting FOB- and CMT-based production forms in the industry. A disadvantage of value-added production function, as Basu and Fernald [1995] pointed out, is that adopting it may yield misleading results if there is imperfect competition or increasing returns to scale. Although this is unlikely to be the case in this study of textile and garment sectors where competition is fierce, value-added function does not allow capturing inefficiency related to the usage of intermediate inputs while output production function does. Hence in this study, the revenue production function is adopted as a more flexible function form.

Non-neutrality of TP is captured by various inputs being interactive with time (i.e., $B_{K_t} \ln(K_{it})t + b_{L_t} \ln(L_{it})t + b_{M_t} \ln(M_{it})t$, in addition to neutral TP effect captured by the sum $\left(\beta_{tt} + \beta_{tt}t^2\right)$.

It is possible that the technology and factors affecting firm-specific technical inefficiency in the textile subsector and the garment subsector are different, thus there are two ways to capture these potential differences: (1) by estimating the model using separate data sets of the two subsectors, an approach that could absolutely capture the potential differences in production technology and the affecting factors but causes loss in degree of freedom; and (2) by using a dummy variable for one subsector and having it interact with input variables in the production function and technical inefficiency-effect variables. While this approach may save some degree of freedom, it also leads to an assumption of the same gamma and sigma-squared in the two subsectors, which may cause distortions in estimated technical efficiency and technical inefficiency effects. In this study, the first approach is chosen, and a rational method of detecting and controlling outliers is used to reduce the effects of the low degree of freedom.

It should be noted that the specifications shown in equation (5) is a general form. All parameters in the form should be estimated first, and variable deletion using LR tests[1] using the "rule of thumb" principle will be then carried out in order to arrive at the best model specification that will be represented in the following part. Some estimated coefficients of equation (6) may be insignificant, and one may think they should be deleted to save a degree of freedom when the LR test of a null hypothesis that they are jointly equal to zero is not rejected at a specific level of significance. However, this process might cause an imbalance in the translog form and could not reflect the true production function. Thus, only the LR test for deletion of insignificant variables in equation (5) is carried out in this study.

2.3. Data

Data source for the study includes two databases—the 1999 and 2001 surveys of textile and garment firms carried out by the Institute of Economics, in cooperation with other research institutions. The 1999 survey collected data for the years 1997 and 1998 from 96 firms, while the 2001 survey gathered data for 1999 and 2000 from 150 firms. If the former is merged with the latter, there would be 207 firms with 492 observations for both the textile and garment subsectors.

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[1]Tests of hypotheses of the parameters in the frontier and inefficiency equations can be conducted through the generalized likelihood ratio test statistic defined as $\lambda = -2\left[LLF(H_0) - LLF(H_1)\right]$ where $LLF(H_0)$ and $LLF(H_1)$ are the values of the log-likelihood function under the null and alternative hypotheses, respectively. This λ statistic has asymptotic chi-square distribution, with degrees of freedom equal to the number of restrictions imposed under the null hypothesis.

3. Technical efficiency analysis

This part will be devoted to analysing the technical efficiency performance in the textile and garment subsectors. In the beginning, the methodology and variable description will be mentioned. Then the general technical efficiency performance of the two subsectors will be the focus, with discussions on technical efficiency frequency and performance by the subsectors. Finally, this section will examine some firm-level determinants of technical efficiency performance in order to draw a clearer picture of the pattern of technical efficiency in the two subsectors.

3.1. Variables description and data analysis

As stated in section 2, the study will work with one-stage Battese and Coelli's econometric approach to estimate the production technology of the two subsectors separately, and then compute firm-level technical efficiency, TEC, TP, and TFP growth.

For the frontier model, the variable of output (*Y*) is the firm's total revenue derived from selling various outputs. There are three inputs used in production: labor, intermediate inputs, and capital inputs. Labor inputs (*LABOR*) are measured by the firms' number of employees, indeed an imperfect measure of labor inputs as it cannot capture difference in labor quality and labor efforts, which could be partially captured by total wage bill. However, the measure of total wage bill as labor input causes the problem of identity and leads to estimations of technical efficiency and inefficiency effects that do not have much economic meaning. Consequently, the measure of labor input as number of employees could be regarded as a logical measure of labor input. Intermediate inputs (*INTER*) include costs of raw materials, fuel, electricity, and water. Values of these inputs, like output value, are drawn from the financial statement of the firm.[2] Capital (*CAP*) as a proxy for capital input is measured by the purchase value of machinery, equipment, and buildings net of accumulative depreciation. This measure of capital, however, is not the best proxy. The different depreciation schemes adopted across firms may result in inaccurate and hardly comparable estimates of true capital stock. In addition, this proxy cannot reflect the flow of the service provided, which is the true measure of capital input. A much better measure of capital is the replacement value of the capital stock, corrected for capacity utilization [Lundvall and Battese 1998]. This measure can reflect the flow of capital service, yet allows capturing the difference in the quality of capital. Unfortunately, data on replacement value and capacity utilization in the survey appear to be unreliable.

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[2]A word of caution with regard to aggregation of outputs and inputs must be said explicitly. Schmidt and Lovel [1979] noticed that evidence of technical inefficiency may be lost in the aggregation process. In the textile and garment industry, whose products are highly differentiated, this problem may be even more severe. Specifically, as long as the aggregation uses the value weights, technical (in)efficiency may encompass output-specific allocative (in)efficiency, which is related to the firm's choice of output mix. Similarly, highly aggregated "material inputs" may mix up technical (in)efficiency and input-specific allocative (in)efficiency. In short, technical (in)efficiency may not be measured accurately due to the aggregation-related problems.

Next is the description of variables used in the inefficiency model. These explanatory variables are identified on the basis of a survey of the literature [IMPR 2001a] and the authors. They include a firm's characteristics such as size, age, ownership structure, location, and targeted markets (export vs. domestic sales), etc. In the literature, a number of measures are used to gauge firm size: number of workers (Pitt and Lee [1981]; Chen and Tang [1987]), total sales (Haddad [1990]; Harrison [1993]), value added [Brada, King, and Ying Ma 1997], and intermediate inputs [Battese and Coelli 1995]. In the current study, firms are classified into small, medium, and large firms. A firm is classified as small (SIZE1) if it has less than 300 employees; a firm is regarded as medium-sized (SIZE2) if its number of employees is between 300 and 1,000; the rest are large. The justification for this specification is that the number of employees is a better proxy for firm size, which could accurately reflect the labor-intensive nature of the subsectors, and is consistent with the definition adopted in the sampling process of the 2001 survey. However, if the number of employees was directly employed as firm size, the serious problems of multicollinearity and influential observations would crop up. As a result, the dummy variable for firm size could be partially employed advantage of firm size with number of employees and does not significantly suffer from the problems.

Firm age (AGE) is the number of years from the year of the firm's establishment to the reported year. In addition to the individual effects of firm size and firm age, the impact of interaction between the two factors on technical inefficiency is also important and is therefore also investigated in a number of other studies. This interaction is thus also adopted in the study. With regard to ownership structure, in the survey questionnaire, firms are classified into one of six ownership types: (1) state-owned enterprises with central management, (2) state-owned enterprises with local management, (3) joint ventures, (4) 100 percent foreign-owned firms, (5) cooperatives, and (6) private enterprises. However, it has been found that cooperatives are fairly similar to domestic private firms, and joint ventures are in many ways similar to firms with 100-percent foreign capital. These similar types are merged to increase the degrees of freedom. In this analysis, three ownership types are used to classify firms into state-owned enterprises, foreign-invested enterprises, and domestic private enterprises. Inefficiency models use state-owned enterprises as the reference group and therefore have two dummy variables of D_PRI (private) and D_FOR (foreign invested) to describe the firm's ownership type.

With regard to location, the study uses two dummy variables of SOUTH and CENTER to classify two firms' locations of the South and the Center thus, the reference group is firms locating in the North. As for targeted market (export vs. domestic sales), such as the size variable, the literature does not provide a unique definition either. Cheng and Tang [1997] suggest that only firms that commit to sell all their products in the world market are defined as export oriented. This means that the international markets still remain important for inward-looking firms. Hill and Kalirajan [1993] use the export share threshold of 50 percent and above to define export orientation. In this study, we also use a dummy variable (D_EXP) with an export share threshold to define whether a firm is export oriented or inward looking.[3] However, instead of a 50 percent threshold, mean value of export shares is used to differentiate these two types of firms. Firms that have export shares above the mean are defined as export oriented; those otherwise are inward looking. This definition appears to more accurately reflect the strong export orientation of Vietnamese textile and garment firms. It should be noted, however, that different thresholds based on 50 percent, median, or mean values do not appear to matter much, given the peculiar shape of distribution of export share, which has a small proportion of firms that are located between these thresholds (see Appendix 5).

The next variable in technical inefficiency effect model is capital structure (CS), which is measured by percentages of external capital to total capital. The last variable in the inefficiency model is the equipment level (EQUI), which is measured by fixed capital per employee. Conclusively, we have the explicit form of the technical inefficiency effect model:

$$\begin{aligned}\mu_{it} = {} & \alpha_0 + \alpha_1 SIZE1 + \alpha_2 SIZE2 + \alpha_3 AGE + \alpha_4 SIZE1 * AGE + \\ & \alpha_5 SIZE2 * AGE + \alpha_6 SOUTH + \alpha_7 CENTER + \\ & \alpha_8 D\_PRI + \alpha_9 D\_FOR + \alpha_{10} D\_EXP + \alpha_{11} CS + \\ & \alpha_{12} EQUI \end{aligned} \tag{7}$$

With respect to subsector classification, it is clear that the technology in the textile and garment subsectors and factors affecting technical inefficiency are potentially different in the textile firms and the garment firms, as mentioned above. Nevertheless, an outstanding feature of the T&G industry is that many textile firms also install a garment production line. The reason for mixed production has been discussed in IOE [2001]. As a consequence, we cannot distinguish textile and garment firms simply by the information on their registration licenses, hence separate estimations of production function for the textile subsector and the garment subsector may be misleading. A good strategy is to pool both textile and garment firms in one sample and use dummy variable(s) to separate these subsectors. However, the assumption that the sigma-squared and gamma are identical in two subsectors might be violated under this approach. Thus, one criterion for classifying firms into the two subsectors is needed.

In this study, the threshold of 50 percent in average production share over the study period is employed to set the boundary between textile and garment firms. This means that firms whose average share of clothing production out of the total production value is 50 percent or higher are defined as garment (or garment-oriented) firms, and firms whose share is below 50 percent are defined as textile (or textile-oriented) firms. This threshold appears to be reasonable for separating textile and

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[3]Due to the relatively small variation of export shares and the small size of the sample, the dummy variable appears to be better than continuous variable, as it allows saving degrees of freedom while still capturing reasonably well the differences between firms with different degrees of export orientation.

garment firms, given the peculiar distribution of the garment share, which is clearly skewed toward two tails of the distribution (see Appendix 4). In addition, the use of the average value of production ensures consistency in identification of production technology of firms as the study period is short. Using this classification, we have 140 and 352 observations for the textile and garment subsectors, respectively. When firms are divided into textile and garment firms, two datasets of the two subsectors are separately estimated.

One problem of small sample size is the presence of outliers, which could significantly influence estimated results. Hence, reasonable method(s) of detecting them should be used to enhance robustness of regression results. In this study, changes in estimated coefficients of variables when one observation is included and excluded, is used as a criterion for detecting outliers, known as "Dfbeta" approach. Consequently, those that cause changes in at least one of estimate coefficients of variables in production function larger than their standard errors are regarded as outliers. Using this approach and the translog form of the production function, 43 observations have been considered outliers in the textile dataset. This abnormally large number is likely to reveal that there are problems in the data or the translog form, a burden of the small dataset. Thus, the Cobb-Douglas form is also employed as an alternative, and the number of influential observations under the Cobb-Douglas production function is only five.

The result of the LR test with original dataset stated in Table 3 rejects the Cobb-Douglas form in favor of the translog form. That means the Cobb-Douglas is likely to be too restrictive to be the reasonable form of the production function of the textile sector. Meanwhile, the translog form is likely to be a burden of the small dataset. Accordingly, the study concentrates on analysing estimate results of the textile subsector, which do not depend on the forms of the production function. Table 1 shows the maximum likelihood estimates of the stochastic production frontiers for the textile subsector after controlling outliers of the two forms of production function with the help of the software FRONTIER 4.1. It should be noted that all variables are deflated to the base year 1997.[4]

These results are remarkably different from the results of the initial dataset (see Appendix 1). This fact shows that the influential observations are really problematic in the initial datasets.

Generally, in estimate results of the textile subsector, at least one of the coefficients (absolute term of square term) of inputs are statistically significant at 5 percent level. The statistical significance of four out of five time-relating variables in the translog production function reveals that the production technology of the subsector has remarkably changed within the study period.

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[4]The T&G firms observed in the survey are involved in the production of the two items—textile and garment. Current prices and constant price indices for textile and garment collected from Statistical Yearbook of GSO are useful for computing output deflator. Input deflators-capital, wage, and intermediate input deflators may be more difficult to derive due to lack of reliable data. These indices will be calculated through proxies collected from various sources.

Table 1. Maximum likelihood estimates of coefficients for the textile subsector

Cobb-Douglas production function			*Variable*	*Translog production function*		
Coeff.	*Std. err*	*T statistic*		*Coeff.*	*Std. err*	*T statistic*
1.425***	0.247	5.760	Constant	-0.650	0.996	-0.653
0.472***	0.032	14.822	L	1.414***	0.300	4.711
0.055**	0.026	2.135	K	0.900***	0.258	3.488
0.563***	0.021	27.145	M	-0.575**	0.248	-2.323
0.023	0.025	0.918	T	0.272*	0.145	1.874
			L*L	0.115***	0.034	3.340
			K*K	-0.071***	0.027	-2.673
			M*M	0.045***	0.015	2.949
			T*T	-0.024	0.018	-1.349
			L*K	-0.096**	0.039	-2.446
			L*M	-0.137***	0.047	-2.913
			K*M	0.117***	0.043	2.736
			L*T	-0.071**	0.029	-2.491
			K*T	-0.053*	0.029	-1.857
			M*T	0.083**	0.031	2.659
1.356*	0.692	1.960	Constant	0.997***	0.340	2.934
-0.744	0.904	-0.823	SIZE1	-0.104	0.365	-0.285
1.805***	0.523	3.453	SIZE2	0.611*	0.306	1.994
0.133	0.191	0.699	AGE	0.110	0.090	1.221
0.069	0.260	0.264	SIZE1_AGE	-0.092	0.121	-0.761
-0.631***	0.148	-4.268	SIZE2_AGE	-0.246**	0.095	-2.599
-0.651***	0.167	-3.898	SOUTH	-0.338***	0.091	-3.726
-0.847	0.673	-1.259	CENTER	0.003	0.119	0.029
-0.723**	0.340	-2.127	D_PRI	-0.242**	0.114	-2.111
-0.407	0.281	-1.449	D_FOR	0.172	0.154	1.118
-0.358**	0.146	-2.452	D_EXP	-0.076	0.062	-1.218
-0.004	0.003	-1.311	CS	-0.001	0.002	-0.808
-0.285***	0.108	-2.649	EQUI	-0.259***	0.052	-4.953
0.094	0.026	3.639	Sigma-squared	0.025	0.005	5.348
0.644	0.145	4.453	Gamma	0.562	0.093	6.068

Table 1. Maximum likelihood estimates of coefficients for the textile subsector (continued)

Cobb-Douglas production function			*Variable*	*Translog production function*		
Coeff.	*Std. err*	*T statistic*		*Coeff.*	*Std. err*	*T statistic*
Mean efficiency = .8202				Mean efficiency = .8045		
Log likelihood function = 4.181168				Log likelihood function = 58.73117		

*, **, *** indicate statistical significance at 10 percent, 5 percent, and 1 percent level, respectively.

L, K, M are denoted for logged values of LABOR, CAP, and INTER, respectively; AGE has been logged as well.

Source: Based on regression results.

To save degrees of freedom in estimating a small number of observations, one may test to delete insignificant variables as mentioned above. However, the current study would like to use initial results for the textile subsector, which are better for comparisons between two forms of the production function. It could be seen that, based on the two results, the coefficients of variables of the technical inefficiency effects model under two specifications of the production function are the same in terms of signs and statistical significance, except for variables for interaction between SIZE1 and AGE, foreign-invested firms (D_FOR) and export orientation (D_EXP). The first two variables are different in terms of sign but not in significance, at any conventional level, and the last one is statistically significant under the Cobb-Douglas form of production function but not in the translog one.

For the garment subsector, things are much easier as there are 352 initial observations and only five outliers under translog form of the production function. Moreover, the LR test also rejects the Cobb-Douglas form in favor of translog one. That means the translog form is reasonable for describing production technology of garment firms observed in the dataset. Table 2 presents the estimate results for the subsector. This is also somewhat different from result with initial dataset (see Appendix 2). As the translog form is reliable for the garment subsector, the technique of dropping insignificant variables to save degree of freedom could be applied without losing any properties and be convenient for analysis. In the initial estimate result, if 6 of 12 coefficients are not statistically significant at 10 percent level, they are tested for dropping. However, this test is rejected at 5 percent level of significance but a test of dropping three variables—two size variables and one dummy for firms located in the Center of which T statistics are less than 1—is not rejected at that level of significance. Thus, the final model is one in which these three variables are excluded in the technical inefficiency effect model.

Table 2. Maximum likelihood estimates of coefficients for the garment subsector

Variable	*Coeff.*	*Std. err*	*T statistic*
Constant	0.109	0.804	0.136
L	0.252	0.315	0.799
K	0.508**	0.221	2.302
M	0.547***	0.100	5.453
T	0.397***	0.144	2.752
L*L	0.088**	0.043	2.071
K*K	-0.016	0.022	-0.743
M*M	0.037***	0.009	4.174
T*T	-0.015	0.018	-0.834
L*K	-0.008	0.052	-0.157
L*M	-0.089***	0.025	-3.538
K*M	-0.012	0.022	-0.543
L*T	-0.024	0.033	-0.707
K*T	0.005	0.025	0.193
M*T	-0.018	0.013	-1.371
Constant	0.049	0.442	0.111
AGE	-0.493**	0.220	-2.241
SIZE1_AGE	0.576**	0.257	2.243
SIZE2_AGE	0.456**	0.227	2.013
SOUTH	-0.793*	0.423	-1.873
D_PRI	-0.208	0.127	-1.640
D_FOR	-1.773	1.306	-1.357
D_EXP	-0.133	0.099	-1.347
CS	-0.004*	0.002	-1.809
EQUI	0.269**	0.122	2.206
sigma-squared	0.236	0.072	3.282
gamma	0.739	0.085	8.693
Mean efficiency = .8095			
Log likelihood function = -84.203291			

*, **, *** indicate statistical significance at 10 percent, 5 percent, and 1 percent level, respectively.

Source: Based on regression results.

At least one of the coefficients of the inputs is statistically significant at 5 percent level, and these coefficients are positive in a way that is consistent with economic theories. In addition, the coefficient of the absolute term of time trend is also statistically significant at 1 percent level. These results show that the technology of the garment subsector has significantly changed within the study period.

3.2. Hypothesis tests

The hypothesis tests of both the stochastic production function and technical inefficiency effects are summarized in Table 3. The null hypotheses are tested using the LR tests mentioned above. The null hypothesis that production technology of the subsectors corresponds to Cobb-Douglas production function is rejected at 5 percent level of significance. The following null hypothesis of no technical inefficiency is rejected at 5 percent level of significance. Under this hypothesis, all coefficients, including constant term and gamma, are jointly equal to zero, and an average production function, which could be estimated using ordinary least square (OLS) procedure, would be an adequate specification of production in the textile and garment subsectors. To have a true picture of technical inefficiency effects and convenience in analysis, insignificance variables in the estimate results of the garment subsector are tested to be dropped, while the null hypotheses of joint insignificance of variables in the technical inefficiency effect model are accepted at 5 percent level of significance. The last null hypothesis that the remaining explanatory variables in the technical inefficiency effect model are jointly equal to zero is rejected at 5 percent level of significance.

Table 3. Results of hypothesis tests

	The Textile-Cobb-Douglas form		*The textile-translog form*		*The garment*	
Null hypothesis	*Calculated value*	*Critical value*	*Calculated value*	*Critical value*	*Calculated value*	*Critical value*
Cobb-Douglas production function*			108.96	18.31	82.36	18.31
No technical inefficiency	75.86	23.68	71.77	23.68	66.54	19.67
Joint insignificance of variables					0.65	7.81
No technical inefficiency effects	61.43	21.03	68.76	21.03	59.61	16.91

*This test is based on initial datasets.

Source: Based on regression results.

3.3. Technical efficiency performance

After having estimates of technical efficiency derived from the regression results, the study computes the geometric means of all firms in the two subsectors. It should be noted that textile firms are calculated under both specifications of the production function. These outcomes are shown in Table 4. (See Appendix 6 for distributions of estimated technical efficiencies.) Two kinds of mean are considered: The first is the unweighted mean, a simple average value of estimated technical efficiency of firms in each subsector. The second is the weighted mean, with the weight as the real revenue of each firm in the sample. The weighted mean may reveal a truer picture of the technical efficiency performance of the subsectors as it incorporates the position of a specific firm in the overall production of the subsector. However, unweighted technical efficiency could be regarded as an informal indicator of the importance of factors affecting technical inefficiency in each firm, and it is useful in comparing the estimated results of other works as they often present simple average technical efficiency. Moreover, comparisons of the two indicators will reveal some characteristics of relationship between size of firms and technical efficiency.

From those indicators, some comments could be made for the textile subsector. First, the weighted mean efficiency is almost the same under two specifications of production function. The unweighted mean is slightly different; these results show that efficiency estimation is reasonably robust. Second, there has been an improvement in technical efficiency over the study period except in year 1999 under the translog specification of the production function. Third, in both weighted and unweighted means, technical efficiency is relatively high compared to other sectors of Vietnam. For example, Minh, Mai, and Dong [2005] found that the technical efficiency of the Vietnam food processing industry in the period 2000-2003 was 60.47 percent. According to Thang [2005], the estimate technical efficiency of the Vietnam iron and steel industry in the period 2000-2003 was 51 percent. The high and concentrative technical efficiency of the textile subsector is explained by the high competitiveness of the textile market as it forces firms to catch up with the frontier.

Table 4. Technical efficiency performance

	Unweighted technical efficiency			*Weighted technical efficiency*		
Year	*The textile-CD*	*The textile-translog*	*The garment*	*The textile-CD*	*The textile-translog*	*The garment*
Overall	82.02%	80.45%	80.95%	82.92%	83.07%	90.15%
1997	79.64%	79.70%	80.21%	80.80%	80.60%	89.24%
1998	81.34%	81.50%	79.06%	82.40%	81.20%	89.63%
1999	82.77%	80.20%	81.84%	83.65%	83.70%	90.02%
2000	83.54%	80.50%	81.63%	84.43%	85.70%	90.85%

Source: Based on regression results.

The increasing trend in means of technical efficiency is also seen in the garment subsector except for the unweighted indicator in year 1998. This means that small firms in 1998 have decreased their technical efficiency. However, they have much improved their technical efficiency in the years 1999 and 2000, and small firms have been faster in increasing their technical efficiency. The wide difference between the weighted and unweighted indicators in the garment subsector compared to that of the textile subsector shows that the size effect has worked more effectively in the garment subsector. In addition, the significantly higher weighted is likely to reveal a positive relationship between firm size and technical efficiency.

Once again, the relatively high average efficiency in the garment subsector shows that garment firms are relatively good at learning from one another. However, an average garment firm is still at 19.05 percent; there is room for improvement in its technical efficiency.

3.4. Determinants of technical efficiency

In this section, the study makes use of the regression results to analyse the relationships between a firm's characteristics and technical efficiency. For the garment subsector, analyses are quite straightforward as there is the reliably unique model, while there are some difficulties in analysing the textile subsector due to the use of the two specifications of the production function. Accordingly, besides concentrations on the variables of which the signs and significance are similar in the two specifications, only some tentative analyses are made for the remaining variables in the model using the Cobb-Douglas production function.

3.4.1. Firm size and age

As mentioned earlier, in the inefficiency model the interactive terms for these variables are also included along with variables of age and size. This allows investigations on how firm size and age (proxy for experience) interact in order to influence the age-efficiency and size-efficiency relationship, respectively. In the estimate results of the textile subsector, the coefficients of the dummy variable for small firms and the interaction variable with age are both insignificant, which means technical efficiency of small textile firms is not significantly different from that of large firms, ceteris paribus. Both coefficients of the dummy for medium textile firms and the interaction variable between medium textile firms and age are statistically significant. Thus, it must be calculated total impact of firm size on mean value of truncated normal distribution of technical inefficient elements to have direction of size effect on technical efficiency, which depends on AGE:

$$\text{Total Impacts} = 1.805 - 0.631 * \ln AGE \qquad (8)$$

This is calculated under the Cobb-Douglas specification; the calculation and analysis are the same under the translog specification, just as the signs of coefficients of relating variables are the same. There is an age threshold for the directions of the relationship between firm size and technical efficiency. If medium firms have an age less than 17.47, the relationship is negative, but if the age of the firm is older than this threshold, the relationship is positive. For the medium firms themselves, this fact is not quite new. The older firms have more experience, thus they could bring into play the advantages of a larger size. Meanwhile, younger firms have not gained experiences enough to benefit from the advantages of a larger size. These size advantages can result in the lower efficiency of medium-sized firms compared to large ones.

For the garment subsector, both small and medium firms have lower technical efficiency compared to large firms, as signs of two coefficients of the interactive term are positive and have no independent firm size effect. This result is different from that of the textile subsector. This difference is likely to be explained by the specification of the firm size in the models. The average labor of small firms in the textile subsector and that in the garment subsectors are 176.25 and 176, respectively. These numbers are not significantly different from each other. But for the large firms, the numbers—2,911.48 and 1,868.61 for the textile and garment subsectors, respectively—are significantly different. The average large textile firm has considerably larger size than the garment one. Given the current level of managerial skills in Vietnam, it is likely that the optimal firm size under the inverted U-shaped relationship between firm size and technical inefficiency in Vietnam's textile and garment industry is smaller than the average size of large textile firms. Thus, there is possible deterioration in the technical efficiency of large textile firms. Meanwhile, the smaller average size of the large-size garment firms is under or just slightly larger than the optimal size, and there is no significantly negative effect of the large-size firms in the garment subsector.

The sign of the coefficients of AGE in the textile subsector is positive under both specifications of the production function. The interactive term between age and small size is also positive under the Cobb-Douglas form and negative under the translog form, but the total effect is still positive for small-size firms under the latter specification. This means age has negative impacts on technical efficiency. It is somewhat controversial to the theories that age—proxy of experience—often has a positive relationship with efficiency. However, it should be noted that both two coefficients are not statistically significant. The result of the coefficients of medium-sized textile firms is quite consistent with the theories and the aforementioned findings that SIZE2 is taken 1 for medium firm that leads to the sum of AGE coefficient, and coefficient SIZE2_AGE is negative, or that age has positive impacts on the technical efficiency of the textile firms.

The relationship between firm age and technical efficiency in the garment subsector presents a mixed picture. Since all coefficients of AGE and its interactions are statistically significant, the impact of AGE is measured by the total coefficients of the AGE variable and its interaction. For the small firm, the total value of the coefficients is positive, which implies that the relationship is negative, or that small-old firms are less technically efficient than small-young firms. Meanwhile, the relationship is positive for medium and large garment firms. These results are explained by the fact that experience does not play as important a role for the small firm as it does for the medium-sized and large one. In addition, if an old firm is small, has outdated technology, cannot invest in technology improvement, and has no capability to rationalize its production, then this leads to low technical efficiency.

3.4.2. Location

The statistically significant and negative coefficients of SOUTH in the estimate results for the textile subsector in both specifications of the production function as well as in the estimate result of the garment subsector imply that the technical efficiency of the South-based textile and garment firms is steadily higher than that of the firms in other regions. Meanwhile, the coefficients of dummy variables for the Center-based textile or garment firms are statistically insignificant. These results mean that the technical efficiency of the textile or garment firms in the Center is not significantly different compared to that of North-based ones. Generally, it is popularly argued that the poor business, infrastructure, and other production conditions of the central region compared to that of the North would have worsened the performance of the center-based garment firms. However, the small fraction of observations on the firms in this region is a rational reason for the insignificance of the estimated coefficients.

It is a fact that the South is widely perceived to have a better business environment and better infrastructure than the North. In addition, with as much as 50 percent of the total industry outputs [MPI 1998], geographical concentration is expected to enable South-based firms to enjoy positive externality and learning effects by taking advantages of other firms' inventions. The concentration is also expected to result in fiercer competition among closely located firms, forcing them to improve technical efficiency. Thus, the higher technical efficiency of the South-based textile or garment firms is not surprising. Additionally, the difference in average technical efficiency of firms in the two regions is also reinforced by the number of employees used as labor input. Under an assumption of a wage bill partially reflecting labor quality, the labor quality of the South-based textile or garment firms is higher than that of the North as the wage bill per labor of the South-based firms is higher (see Appendix 3). Therefore, the South-based firms have understated labor inputs and overstated technical efficiency.

3.4.3. Ownership

Coefficients of dummy variables for foreign-invested textile firms have opposite signs in two specifications, although both coefficients are statistically insignificant. It is a popular argument in Vietnam that foreign-invested firms have higher efficiency than do the other types due to their advanced managerial skills, technology, and marketing knowledge. However, two distortions in the measurements of output and input of foreign-invested firms may affect estimate results of the dummy variables for foreign-invested firms. This leads to a question of possible measurement problems. On the input side, price distortions against the foreign sector may result in overestimation of input quantities that are proxied by values of inputs as done in this study. Indeed, due to the existing dual pricing system in Vietnam, foreign firms have to pay higher dollar-indexed prices for a number of infrastructure services such as electricity, water, telecommunication, airfare, etc., thus their quantities of inputs used for production are inflated compared to domestic firms. On the output side, the "transfer pricing" phenomenon in the foreign sector, i.e., deflating the price of final products that are exported to mother enterprises in the countries of origin, is quite often reported in the press (e.g., *The Evening News* July 12, 2002). Transfer pricing also affects the costs of imported inputs, which are often overstated by foreign-invested firms. Therefore, to establish a more reliable ownership-efficiency link for such type of firms, all these distortions should be taken into account and somehow quantified, but this is clearly beyond the scope of this study.

Turning now to private textile firms, the estimation results imply that this type of firm performs better in terms of technical efficiency than state-owned ones. Actually, within the study period, there have been favorable conditions granted to state-owned enterprises in general and textile firms in particular. However, there have been several possible reasons to explain the better performance of the private garment firms in terms of technical efficiency. First, the dynamic characteristics of private firms have been partially made-up disadvantages, especially when the business environment changed significantly within the study period. Second, the existence of family labor, which has been more popular in private textile firms, could understate labor input of this type of firm as family labor creates more effort [Page 1984], which results in an overestimation of the efficiency performance of the private firms. Third, the liberalization of regulations in 1999-2000 has made the most positive impact on private firms in general and on garment firms in particular.

Both coefficients of the dummies in the estimation result for the garment subsector are negative but not statistically significant. Again, favorable conditions given to state-owned garment firms in terms of credit, export quota, and others have neutralized inefficiency caused by problems of management or technology. In addition, the aforementioned issues in measuring inputs and outputs of foreign-invested firms make no difference to this type of firm or to state-owned ones in terms of technical efficiency.

3.4.4. Export orientation

The dummy variables for export orientation in the estimate results of the textile subsector are not consistently significant across the two specifications—the coefficient is negative and statistically significant at 5 percent level under the Cobb-Douglas specification of the production function, and negative but statistically insignificant under the translog specification. These results may imply that export orientation impacts positively upon the technical efficiency of textile firms. In addition, the small number of observations may also be a reason for the insignificance of the coefficient in the translog production function model.

The coefficient of the dummy variable for export orientation in the estimate result for the garment subsector is positive but statistically insignificant, which shows that export orientation does not have a significant impact upon technical efficiency. In fact, the garment subsector is extremely export oriented, with mean export share of 89.89 percent; 331 out of 347 observations have export shares larger than 50 percent. This figure shows that export orientation is not a distinct feature of garment firms. As a result, the export-orientation dummy variable is statistically insignificant.

3.4.5. Çapital structure

The coefficients of the capital structure are negative and statistically insignificant in the estimate results of both specifications of the textile subsector. In other words, the relationship between capital structure and technical efficiency is not statistically different from zero. But the coefficient of the variable in the garment subsector is negative and statistically significant at 10 percent level. This difference in the relationship between capital structure and technical efficiency in the two subsectors is caused by their nature. The textile subsector includes a relatively small number of large firms, thus it is easier for them to have external capital because the banks prefer to lend to large firms. This leads to the textile firms themselves not sufficiently managing the external capital. Additionally, the textile subsector has a relatively greater number of state-owned firms, and the weak monitoring mechanism of state-owned banks against state-owned firms has worsened the internal management of external capital in the state-owned textile firms. These negative elements have neutralized the positive effects of the winner-picking principal in the lending process of banking systems.

On the other hand, the garment subsector contains a greater number of small firms. The small garment firms themselves lack internal capital, and they have to cope with others to have external capital. The positive impact of the winner-picking principal on technical efficiency would take effect in this case.

3.4.6. Equipment level

This characteristic and its relationship with technical efficiency are not, indeed, well supported in the literature. However, attempts to drop it have not been successful. In some papers [Minh, Mai, and Dong 2005], equipment level is explained as a proxy for embodied technology, and it links to a worker's ability to internalize advance technology. Others conjecture that it is a representative of labor quality; however, there is no reliable information on labor quality, and it is impossible to test this statement. Others propose to omit equipment level as a variable, which the translog form production function ignores. Therefore, we need further information to explain the estimated results of this characteristic.

3.5. TFP growth analysis

This subsection shall use the methodology described in subsection 2.1 to investigate TFP growth and its components—TEC and TP. It should be noted, however, that the panel datasets from which the relevant rates are derived are heavily unbalanced. The textile panel dataset under the translog production function consists of 14 observations (firms) for 1997-1998, seven observations (firms) for 1998-1999, and 20 firms for 1999-2000; these numbers under the Cobb-Douglas production function are 27, 13, and 39, respectively. In the garment subsector, the panel data are better that the panel observations for 1997-1998, 1998-1999, and 1999-2000 are 63, 26, and 108, respectively. The too-small size of the panel dataset may result in large measurement errors and, hence, unreliable aggregate estimates. Therefore, aggregates derived from estimates for the textile firms do not appear to be reliable. Thus, the results of the subsequent analysis should be interpreted as only preliminary and indicative. However, the study still attempts to use some other analyses to use up the information. Two analyses are quite reliable: the LR tests for no TP, and comparisons between unweighted and weighted aggregates.

3.5.1. The textile subsector

Hypothesis test of no technical progress

The hypothesis of no TP is equivalent to the null hypothesis that coefficients of T, T*T, TL, TK, and TM are jointly equal to zero under the translog specification or T is equal to zero under the Cobb- Douglas production function. If this hypothesis is not rejected, TFP and TEC are identical. Table 5 shows the test results for both specifications of the textile subsector and the garment subsector.

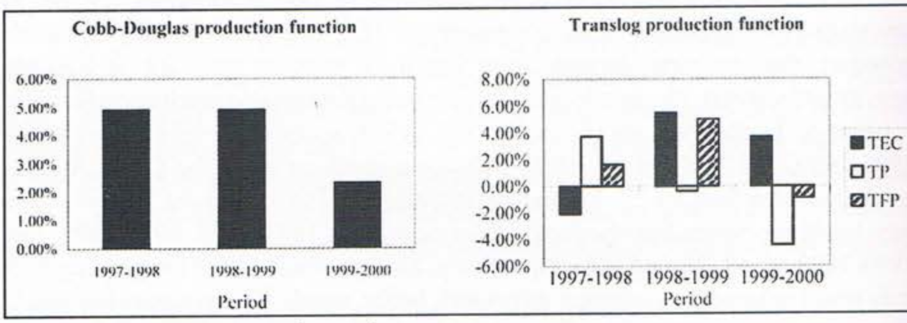
Table 5. Results of tests for no technological change

	The textile subsector				*The garment subsector*	
	Cobb-Douglas		*Translog*			
Null hypothesis	*Calculated value*	*Critical value*	*Calculated value*	*Critical value*	*Calculated value*	*Critical value*
No technological change	0.144	3.84	13.001	11.070	28.445	11.070

Source: Based on regression results.

In the textile subsector, there is no significant TP under the Cobb-Douglas form of the production function, but this is recorded in the translog one. Since the translog form is better at describing the production process in this subsector, the latter result could be more reliable. Thus, the TFP in the textile subsector under the Cobb-Douglas is equal to the TEC. Meanwhile, it comprises the TEC and TP in the translog form. Figures 2 and 3 show the unweighted and weighted TFP of the textile subsector under two specifications of the production function. It should be noted again that the used weight is the revenue of each firm.

Figure 2. Unweighted TFP and its components: TEC and TP of the textile subsector

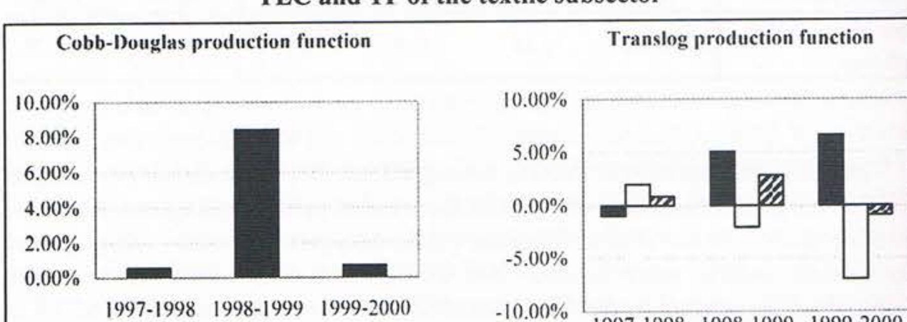


Source: Based on regression results.

With the Cobb-Douglas specification of the production function, we record an increase in technical efficiency. This seems to be consistent with results of technical efficiency estimation in section 3.3. However, the shape of the increase is different when the weight is taken into account, although positive TECs are still seen. In the periods 1997-1998 and 1999-2000, small firms are better in terms of improving their technical efficiency, while large ones dominate in the period 1998-1999. It should be recalled that there are no considerable changes in size behavior in the mean technical efficiency performance presented in section 3.3. This fact implies that panel textile firms may not be good representatives of textile firms as a whole, especially in the period 1998-1999, as we only have 13 panel textile firms.

The number of panel textile firms under the translog specification of the production function is even smaller, and so no reliable analyses could be made. Tentatively, technical efficiency improvement is found, but the TP is negative in 1999 and 2000, leading to negative TFP in this period.

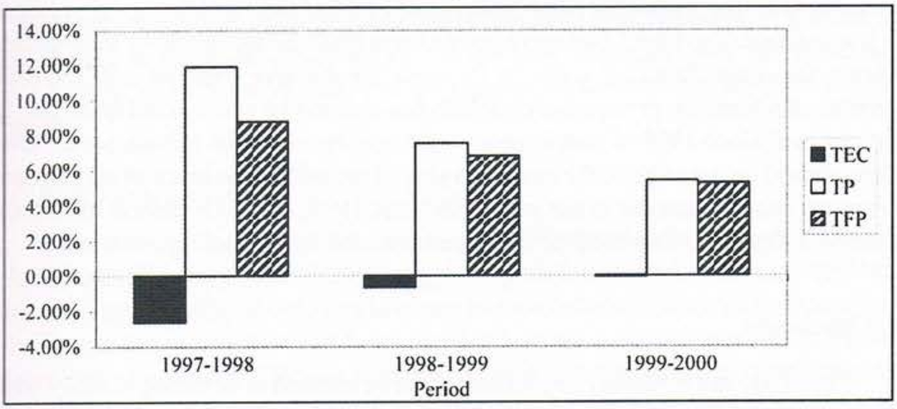
Figure 3. Weighted TFP and its components: TEC and TP of the textile subsector



Source: Based on regression results.

3.5.2. The garment subsector

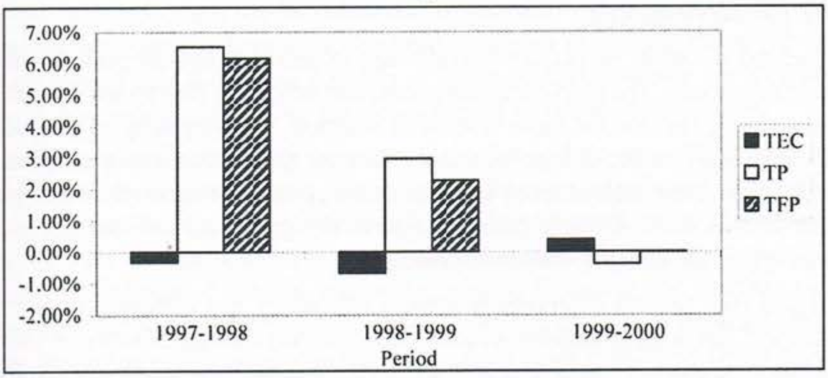
Figure 4. Unweighted TFP and its components: TEC and TP of the garment subsector



Source: Based on regression results.

The statistically significant coefficient of absolute term of time and the rejection of the LR test of no TP make it meaningful to calculate this component of TFP. Figures 4 and 5 show the garment subsector's unweighted and weighted TFP and its components. As with technical efficiency, size effects remarkably work in the TFP performance of the garment subsector. Generally, technical progress dominates the TEC, and a downtrend is observed in the technical progress as well as the TFP. The TEC of large firms seems to improve as weighted TFP registers as positive in the last year of the study period.

Figure 5. Weighted TFP and its components: TEC and TP of the garment subsector



Source: Based on regression results.

The weighted TFP is smaller than the unweighted TFP in all three years. This result implies that small garment firms have outperformed large ones in terms of TFP growth. The better TFP of small garment firms is attributed to their good technical progress but not to their improvement in technical efficiency. Meanwhile, the large garment firms are somewhat better in terms of TEC but their technological progress is less brilliant. The high TP of small textile firms could be explained by their efforts during the Asian financial crisis to improve competitive capacity and increase investments from the private sector, which has dominated small-sized firms due to the removal since 1998 of restrictions on the operations of the private sector. One thing should be noted here: the average value of technical efficiency of all garment firms are seen to increase in the years 1998 and 1999, but the technical efficiency change is negative. This conflict could be attributed to unpanel observations.

4. Conclusion

This study has explicitly applied an effective method in detecting outliers with alternative specifications of production function to get acceptably reliable results, given data restrictions. The study has also investigated the characteristics of various firms as sources of technical efficiency to gain information on technical efficiency performance and its determinants, as the results of this investigation are quite important for policy implications. However, some shortcomings still exist, which could not be solved by available data and related information. This section is divided into three parts: main findings are first concluded, then several policy implications derived from the findings are pointed out. Lastly, shortcomings are presented.

4.1. Key findings

First, the estimate results of the technical efficiency performance and technical inefficiency effect model in the textile subsector seem to be insignificantly affected by the forms of the production function, whereas the translog form is quite suitable for the garment subsector.

Second, the study reveals a relatively high technical efficiency performance of the two subsectors. The high competitiveness and relatively liberalized regulations are two strong reasons for these results. In addition, the simplicity of production technology also resulted in high technical efficiency as it allows textile and garment firms to learn from each other in order to catch up on their theoretical maximum output. This is more strongly demonstrated in the garment subsector, given that technology of the garment subsector is simpler.

Third, the factors affecting technical efficiency are different in the two subsectors. The private medium-size textile firms with enough experience, located in the South, export-oriented, and with a high equipment level are most technically efficient. Whereas, size, age, location, capital structure, and equipment level are factors that affect technical efficiency significantly in the garment subsector, of which small, medium size, equipment level, or age of small-size ones have negative impacts on technical efficiency. The remainders have positive relationship with technical efficiency.

Fourth, there have been TP in both subsectors. The TFP presented mixed results in the textile subsector, while positive TFP is clearly seen in the garment subsector. The change in technical efficiency of the garment subsector over the years has been modest, even negative, thus the TFP growth has been largely attributed to TP change.

4.2. Policy implications

Given the high level of technical efficiency of Vietnam textile and garment firms, priority should be given to technical progress to shift the production frontier upward. This implies that policy should aim to create an innovation-friendly environment and provide necessary incentives to firms that can lead the way and become an engine of productivity growth. Efficient foreign-invested firms can be good candidates, as they can bring in not only capital, but technology and management skills as well, which are key to technical progress but have remained very scarce in Vietnam. The challenge, therefore, is to make appropriate incentives for attracting efficient foreign direct investments and crowding out inefficient ones.

The study has confirmed the well-established fact that business environments in the North and the Center are less favorable than that of the South. Poor infrastructure is a current problem of the Center, thus some forms of government interventions, such as the provision of disproportionately large investments in roads, education, and health, can really help. Whereas the bureaucracy is an outstanding problem of the North [VCCI 2005], the transparency of provincial policies, investment procedures, and access to infrastructure are areas that should be improved in the North provinces.

Despite unfavorable conditions against private firms, they seem to outperform state-owned ones in the textile subsector, which shows that private firms are an important force for the development of this subsector in coming times. Thus, the policies should aim at creating equality in business environments for all types of ownership in order to accelerate the development of private textile firms.

The positive relationship between capital structure and efficiency shows that garment firms lack capital. Thus, the banking system should lend more to the subsector. The lending objective should be the medium- and small-sized firms, as their internal capital is more restrictive, and it could be expected that the marginal effects of external capital are higher. However, the banking system should also support selected large firms in investing in new technology, because strong technology diffusion in the subsector could quickly improve the production technology of other firms.

4.3. Shortcomings

Some of the study's limitations should be addressed in further research. First, the number of employees should be adjusted by labor quality in order to have an accurate measure of labor input.

Second, improvement of the research may be achieved by adopting a better measure for capital, one that would properly reflect the flow of capital input adjusted by the quality of its stock. In this case, replacement value of capital stock corrected for capital utilization should be chosen for a more convincing analysis.

Third, improvements can be made if distortions in inputs and outputs measured in monetary terms could somehow be removed. Otherwise, the picture of technical efficiency performance based on ownership is not as convincing. Ideally, one should obtain firm-specific prices (or price indices) of inputs and outputs. However, this task seems nearly impossible, as prices (or price indices) for inputs and outputs are extremely difficult to collect for the highly dynamic textile and garment sectors, whose products and input profiles change very fast. One way out is to do what was just mentioned: correct values of inputs and outputs by taking into account different prices faced by firms due to differences in ownership forms.

Finally, the results of TFP growth and technical progress could be considerably improved if more data is available.

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Appendix 1. Estimated results of initial datasets: the textile subsector

Cobb-Douglas production function			*Variable*	*Translog production function*		
Coeff.	*Std. err*	*T statistic*		*Coeff.*	*Std. err*	*T statistic*
1.306	0.834	1.566	Constant	0.686	1.014	0.676
0.324	0.070	4.598	L	1.218	0.274	4.452
0.082	0.062	1.327	K	-0.140	0.202	-0.695
0.624	0.039	16.053	M	0.413	0.267	1.544
0.051	0.038	1.353	T	-0.152	0.180	-0.841
			L*L	0.076	0.042	1.807
			K*K	0.012	0.010	1.188
			M*M	0.076	0.014	5.537
			T*T	-0.010	0.021	-0.487
			L*K	-0.016	0.043	-0.366
			L*M	-0.154	0.044	-3.466
			K*M	-0.017	0.028	-0.616
			L*T	-0.060	0.032	-1.876
			K*T	0.057	0.022	2.547
			M*T	0.004	0.029	0.146
0.004	0.868	0.005	Constant	1.175	0.487	2.416
-0.013	0.949	-0.013	SIZE1	-0.835	0.643	-1.298
0.019	1.109	0.017	SIZE2	0.744	0.426	1.747
-0.015	0.756	-0.020	AGE	0.074	0.123	0.601
-0.028	0.867	-0.032	SIZE1_AGE	0.072	0.231	0.312
0.020	0.818	0.024	SIZE2_AGE	-0.286	0.128	-2.234
-0.010	0.665	-0.015	SOUTH	-0.334	0.085	-3.909
0.013	1.831	0.007	CENTER	-0.110	0.163	-0.674
-0.004	0.864	-0.005	D_PRI	-0.339	0.145	-2.335
-0.001	1.111	-0.001	D_FOR	0.054	0.174	0.312
-0.007	0.833	-0.009	D_EXP	-0.182	0.082	-2.209
-0.010	0.085	-0.119	CS	-0.002	0.002	-1.325
0.010	0.312	0.031	EQUI	-0.238	0.067	-3.576
0.138	0.049	2.790	Sigma-squared	0.071	0.013	5.370
0.117	0.718	0.163	Gamma	0.363	0.148	2.457
Mean efficiency = 0.9651				Mean efficiency = 0.8038		
Log likelihood function = -52.062				Log likelihood function = 2.417		

Source: Based on regression results.

Appendix 2. Estimated results of initial datasets: the garment subsector

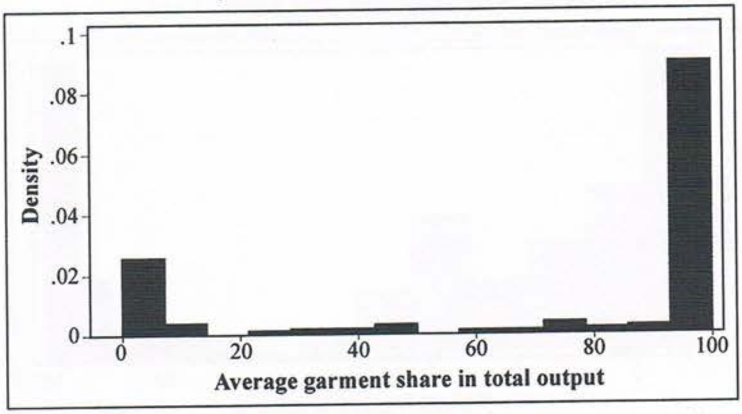
Variable	*Coeff.*	*Std. err*	*T statistic*
Constant	0.671	0.957	0.702
L	-0.257	0.308	-0.832
K	0.827	0.170	4.859
M	0.508	0.105	4.814
T	0.343	0.149	2.302
L*L	0.146	0.047	3.103
K*K	0.006	0.013	0.504
M*M	0.039	0.009	4.448
T*T	-0.009	0.017	-0.501
L*K	-0.083	0.046	-1.817
L*M	-0.050	0.026	-1.921
K*M	-0.038	0.021	-1.798
L*T	-0.017	0.030	-0.577
K*T	0.014	0.022	0.647
M*T	-0.030	0.013	-2.212
Constant	0.413	0.624	0.661
SIZE1	-1.010	0.781	-1.293
SIZE2	-1.114	0.831	-1.341
AGE	-1.294	0.562	-2.303
SIZE1_AGE	1.351	0.576	2.345
SIZE2_AGE	1.142	0.552	2.070
SOUTH	-0.965	0.297	-3.242
CENTER	0.450	0.208	2.167
D_PRI	-0.187	0.142	-1.315
D_FOR	-1.988	0.750	-2.651
D_EXP	-0.274	0.124	-2.214
CS	-0.007	0.003	-2.391
EQUI	0.660	0.173	3.815
sigma-squared	0.382	0.094	4.048
gamma	0.856	0.045	18.943
Mean efficiency = 0.78423			
Log likelihood function = -100.432			

Source: Based on regression results.

Appendix 3. Statistics of "real" wage bill per worker

Location	*Mean*	*Std. Dev.*	*Min*	*Max*
THE TEXTILE SUBSECTOR: OBSERVATIONS UNDER TRANSLOG SPECIFICATION				
The South	8.969	3.713	1.538	16.051
The North	6.657	5.203	0.894	27.763
THE TEXTILE SUBSECTOR: OBSERVATIONS UNDER COBB-DOUGLAS SPECIFICATION				
The South	9.356	3.926	1.265	21.376
The North	7.236	6.196	0.894	34.739
THE GARMENT SUBSECTOR				
The South	9.113	3.130	1.123	17.888
The North	5.731	2.963	0.659	15.401

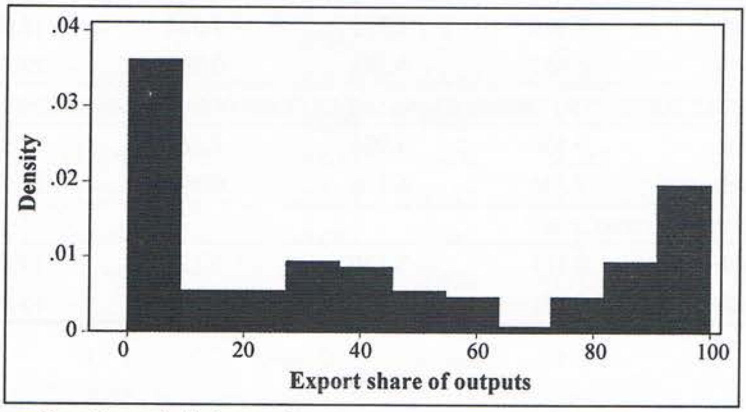
Appendix 4. Distribution of average garment share by firm over the study period



Source: Based on calculation results.

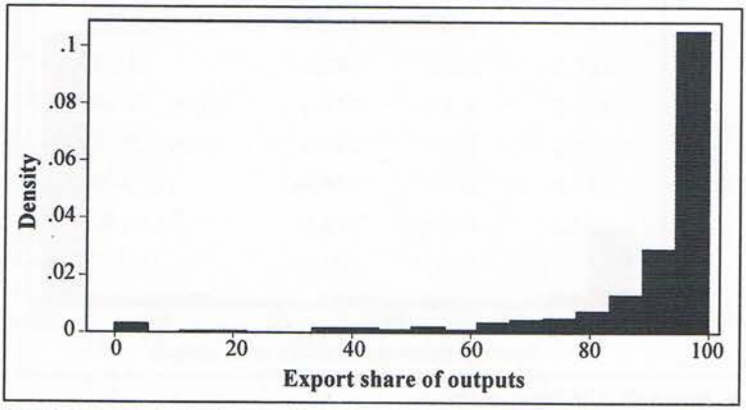
Appendix 5. Distribution of export share

The textile subsector



Source: Based on calculation results.

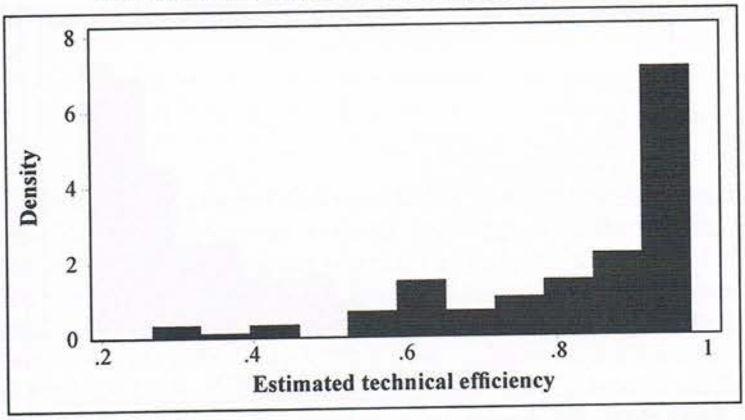
The garment subsector



Source: Based on calculation results.

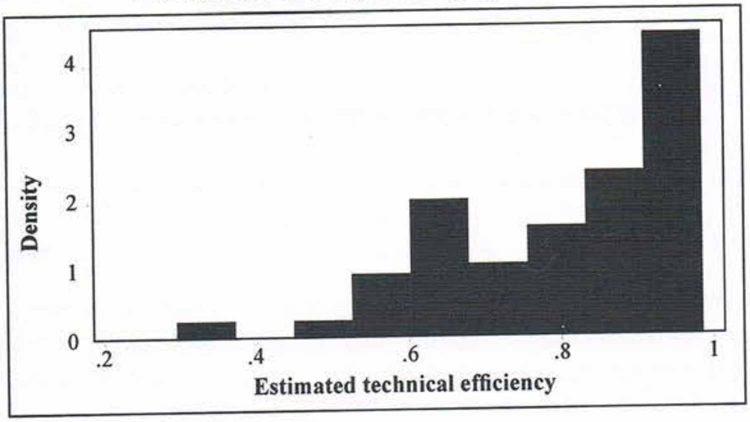
Appendix 6. Distribution of technical efficiency

The textile subsector, Cobb-Douglas specification



Source: Based on calculation results.

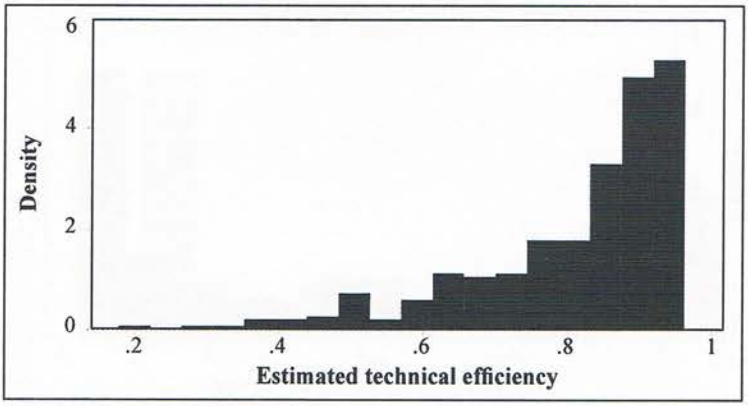
The textile subsector, translog specification



Source: Based on calculation results.

Appendix 6. Distribution of technical efficiency (continued)

The garment subsector



Source: Based on calculation results.