Has Low Productivity Constrained Competitiveness of African Firms?: Inter-Regional Comparison of Productive Efficiency and Competitiveness of Garment Firms.*

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Abstract

It has been argued that the slow growth of productivity is one of critical sources of stagnation of the African manufacturing sector but empirical supports are limited. Using the inter-regional firm data of the garment industries, productive efficiency and its contribution to unit cost are compared between Kenya and Bangladesh which is the one of the largest exporters in the world. Our estimates have indicated that there is no clear gap in the average technical efficiency of the two industries despite conservative estimation, while allocative efficiency is significantly lower in the Kenyan industry. Unit cost greatly differs between the two industries, where impact of inefficiency on unit cost is small and labour cost appears to have the largest impact. High wages in Kenya result from higher skills required for small scale production as well as higher price levels in the country., Productivity does not account for the stagnation in the garment industry.

1. Introduction

A number of economic studies on the African manufacturing sector have implicitly or explicitly recognized poor productivity as a source of long stagnation in that sector. In particular, literatures focusing on the technical capacity of African firms have reported that most of the African firms have used obsolete technology and equipment, and that their technical knowledge and skills are poorer than those in Asia (Lall [1999], Biggs et al. [1995], Pack [1993] among others). They argue that lack of knowledge and skill has hindered the improvement of productivity and the upgrading of process, and consequently, African firms have lost competitiveness even in the domestic market where competition with imports (particularly Asian products) has become acute under the globalization. Other literatures argue that the poor business environment in Africa has increased the risk of contract enforcement, the cost of production and transportation, and uncertainty in the macroeconomic

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environment, and these have discouraged African firms from investment (for example Collier and Gunning [1999]). Though not stating explicitly, these studies imply that risk and uncertainty have adversely affected productivity by discouraging investment in technology, such as R&D and skill formation[1].

After 1990s, an growing number of studies measured technical efficiency at the firm level due to the increased availability of firm data. While these studies have revealed the characteristics of African firms in many important aspects, they are not suitable to compare African firms with firms in other regions because coverage of most surveys is limited to sub-Saharan Africa. Some studies compared the average technical efficiency measured by studies in Africa and other regions, and found that the average of African firms tends to be lower than that of other regions (Tybout [2000], Biggs et al. [1995]). Such comparisons, however, are not consistent unless they are estimated by a common production frontier. Despite common recognition, poor productivity of African firms has not yet been empirically shown.

Though productivity is an important factor of competitiveness, it is not the sole determinant even in markets where price competition dominates. Factor costs, scale economy and allocation of factors (how efficiently a firm allocate factors to minimize cost) also affect the cost of production. Therefore, to understand why African firms are not competitive in the world market, a comparison of the productivity and its effect on competitiveness is needed. Using the original firm data from Asia and Africa, this study attempts to make a consistent comparison of productivity, and to demonstrate whether productivity is the main source of weak competitiveness of the African firms.

In the next section, a framework for an inter-regional comparison of firm performances is described, which includes the methodology used for measurement of productivity and identification of its impact on competitiveness. Results of empirical analysis are shown in the third section, and conclusions are presented in the last section.

2. Methodology

In this paper, focus is placed on the garment industry, which specializes in the assembly process of clothing production. Because of its relatively simple and labour-intensive technology, the industry has grown in many developing countries, but there is a sharp contrast between Africa and the other developing regions. The garment industry had started to grow in the 1960s in East Asia and in the 1970s and 80s in Southeast Asia, and garment exports preceded the economic growth in the region. Recently, garment exports have grown in LDCs including Bangladesh, Vietnam, and Cambodia, and they have become large exporters in the world market. In contrast, the garment industry in African

[1] Pattilo and Soderbom [2000] suggested that risk averse firm may not choose productive technology when it is riskier than existing ones in the African business environment.

countries did not penetrated the export market with exception of Mauritius, and has even lost most of its share in domestic markets after trade liberalization. Lagging for several decades, garment exports started to grow in several African countries after 2000 due to preferential access given by US. However, this growth trend was lost in 2005 when the termination of the Multi-Fiber Agreement (MFA) led to free market regime in the world textile market. The garment industry is a good case to see the contrast of performance in African and the other regions.

Performance and competitiveness are compared between Kenya and Bangladesh. The Bangladeshi garment industry has grown since the 1980s and has become the eighth largest exporter in the world (2002, WTO [2003]). While growth of the industry was triggered by technical cooperation by a Korean firm, local firms have learned technology swiftly, and now most of exports are from local firms (Rhee and Belot [1989]). Conversely, the Kenyan garment industry used to be the largest cluster in East Africa, but trade liberalization in the early 1990s has resulted in the influx of imports of secondhand and Asian clothes, and the industry has drastically shrunk (McCormick et al. [1999]). Exports have grown since 2000 when the US government provided preferential access to African countries under the African Growth and Opportunity Act (AGOA), but scale is small and all exports are from multinational firms, and few local firms benefited from the export opportunity (Fukunishi et al. [2006]). Our comparison should provide a clear contrast of industrial performance despite similar income levels between the two countries; GDP per capita in Kenya is $418 while that in Bangladesh is $386 (2003, World Bank [2006]).

2.1 Productivity Measurement

Technical efficiency is estimated from the pooled samples of Kenya and Bangladesh using the stochastic production frontier model. In this framework, production frontier represents the maximum output that technology exhibits given the quantity of inputs, and actual production of an individual firm may be less than the frontier due to technical inefficiency and random shock on production. Assuming a Cobb-Douglas form, production function is expresses as

$$Y_i = \alpha K_i^{\beta 1} L_i^{\beta 2} * TE_i * error_i , \quad (1)$$

where *Y*: output, *K*: capital, *L*: labour, *TE*: technical efficiency between 0 to 1, *error*: stochastic errors with mean at one, and *i* represents an individual producer. For a firm operating on the frontier, technical efficiency is equal to one, and between 0 and 1 for those off the frontier. Estimation is based on log form.

$$\ln Y_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i - u_i + v_i , \quad (2)$$

where β_0=exp(α), u_i= - ln(TE_i), $u_i>0$ and v_i= ln($error_i$). Inefficiency, u_i, is assumed to follow a half normal distribution, $N^+(0, \sigma_u)$, or a truncated normal distribution, $N^+(\mu, \sigma_u)$, and the error component, v_i, is assumed to be normally distributed with mean zero, $N(0, \sigma_v)$. Separation of v_i and u_i from regression residuals (ε_i= $-u_i+v_i$) follows the methodology by Jondrow et al. [1982], which utilizes the conditional distribution of u given ε derived from the distributional assumption on u and v [2]. To have a consistent estimation of efficiency between Kenyan and Bangladeshi samples, an assumption of a common production frontier must be held.

Value added has been used instead of gross output for estimation, because many of the samples take subcontract orders in which material is provided by a buyer and their gross outputs do not include material value. Bruno [1978] justified use of value added in a production function when share of material to gross output is constant (Leontief type) and material price is determined in a competitive market. To see whether use of value added causes bias in estimation, a frontier function based on gross output is also estimated for non-subcontractors.

To measure efficiency of transformation from inputs to output precisely, capital value is adjusted by utilization rate.

2.2 Contribution of inefficiency to competitiveness

With efficiency measures, we then want to know the contribution of efficiency to competitiveness. Focus has been placed on impact of the inefficiency on price competitiveness. In the garment market, competition is determined primarily by quality, delivery and price, while price and delivery are most important for low-priced products that Kenyan and Bangladeshi firms are producing (Lall and Wignaraja [1994]). Although it is not the sole determinant, price is crucial in determining the competitiveness of products. Assuming that price competitiveness is represented by unit cost, we attempt to know how much of the difference of unit costs between Bangladeshi and Kenyan firms is explained by inefficiency.

Exploiting the duality of the Cobb-Douglas function, the cost function can be obtained from the production function and the cost minimization condition. With the production function (1), a firm minimizes cost, $C_i = r_iK_i+w_iL_i$, where r_i is rental price of capital and w_i is wage. It is assumed that the firm may misallocate inputs, and then, actual cost becomes greater than minimum cost. This gap of input allocation is allocative inefficiency. The first order condition of cost minimization with allocative inefficiency is expressed as

$$\frac{K_i}{L_i} = \frac{\beta_1 w_i}{\beta_2 r_i} * AE_i ,$$

where $AE_i > 0$ and it is equal to one when capital-labour ratio is optimal with respect to wage-rental ratio.

From the above two equations, the input demand functions are given by

[2] For loglikelihood functions and estimation methodology of u, see Appendix 2.

$$K_i = \left[\frac{\beta_1}{\beta_2} \alpha^{\frac{-1}{\beta 2}} * \frac{w_i}{r_i} * \left(\frac{Y_i}{TE_i * error_i} \right)^{\frac{1}{\beta 2}} AE_i \right]^{\frac{\beta 2}{\beta}}$$

$$L_i = \left[\frac{\beta_2}{\beta_1} \alpha^{\frac{-1}{\beta 1}} * \frac{r_i}{w_i} * \left(\frac{Y_i}{TE_i * error} \right)^{\frac{1}{\beta 1}} AE_i \right]^{\frac{\beta 1}{\beta}}$$

where $\beta=\beta_1+\beta_2$. Multiplying respectively by factor prices, the cost function is given by

$$\hat{C}_i = r_i K_i + w_i L_i = A r_i^{\frac{\beta 1}{\beta}} w_i^{\frac{\beta 2}{\beta}} \hat{Y}_i^{\frac{1}{\beta}} TE_i^{\frac{-1}{\beta}} \overline{AE_i} , \qquad (3)$$

where $A = \beta \left(\alpha \prod_n \beta_n^{\beta n} \right)^{\frac{-1}{\beta}}$, $\hat{Y}_i = \alpha K_i^{\beta 1} L_i^{\beta 2} TE_i = Y_i / error_i$ (estimated output from the production function), and $\overline{AE}_i = \frac{1}{\beta} \left[\beta_1 AE_i^{\frac{\beta 2}{\beta}} + \beta_2 AE_i^{\frac{-\beta 1}{\beta}} \right]$. The first through fourth terms on the right hand side compose the cost frontier function, and the last two terms represent dispersion of actual cost from the frontier; they are the costs of technical inefficiency and allocative inefficiency respectively[3]. $\overline{AE} \geq 1$ and equality holds when AE=1; the cost of allocative inefficiency is null when there is no inefficiency in input allocation.

Note that the cost expressed in (3) accounts only for utilized inputs, since capital in the production function is adjusted by the utilization rate. Thus, actual cost is greater than the cost given by (3) if the firm has idle capital (in fact most of firms do), and this also should be included in the cost of allocative efficiency. Adding the cost of idle capital, η, in multiplicative form, the actual cost is described as

$$C_i = \hat{C}_i * \eta_i ,$$

where $\eta \geq 1$. Dividing the cost by estimated output, the unit cost can be expressed by factor prices, production scale, and inefficiency.

$$D_i = \frac{C_i}{\hat{Y}_i} = A \cdot r_i^{\frac{\beta 1}{\beta}} w_i^{\frac{\beta 2}{\beta}} \hat{Y}_i^{\frac{1-\beta}{\beta}} TE_i^{\frac{-1}{\beta}} \overline{AE}_i \cdot \eta_i .$$

Figure A illustrates the cost of technical and allocative efficiency on isoquant. The isoquant curve indicates the combination of inputs, K and L, required for a fixed amount of products, say one unit. While the point a represents the minimized inputs combination under the wage-rental ratio, a firm utilizes the inputs at c which has a higher cost. This cost difference appears to be the result of the

[3] In the frontier analysis literature, costs of technical and allocative inefficiency are jointly termed as cost (in)efficiency (see for example, Kumbhakar and Lovell [2000]).

fact that a firm have the wrong capita-labour ratio (a→b), and that it has used more inputs than the minimized (b→c). The former is the cost of allocative inefficiency, and the latter is that of technical inefficiency. For the firm that has idle capital, the cost is added to the cost of allocative inefficiency (c→d).

A comparison of unit cost between Kenyan and Bangladeshi firms and the contribution of each component to this difference are of our interest. By taking the ratio of the unit cost of firm *i* to firm *j*, we have the following identity.

$$\frac{D_i}{D_j}=\left(\frac{r_i}{r_j}\right)^{\frac{\beta 1}{\beta}}\left(\frac{w_i}{w_j}\right)^{\frac{\beta 2}{\beta}}\left(\frac{\hat{Y}_i}{\hat{Y}_j}\right)^{\frac{1-\beta}{\beta}}\left(\frac{TE_i}{TE_j}\right)^{\frac{-1}{\beta}}\frac{\overline{AE}_i\cdot\eta_i}{\overline{AE}_j\cdot\eta_j} \qquad (4)$$

The first and second terms in the right hand side are contributions of the difference of factor prices to the difference of unit costs, and the third term represents the contribution of scale economy. The fourth term is the contribution of technical inefficiency followed by allocative inefficiency[4].

To have decomposition by (4), a cost function must be known. The cost function (3) is deterministic because the stochastic error is absorbed by $\hat{Y}=Y/error$. Since parameters and technical efficiency are given by the production functions, only $\overline{AE}$, the cost of allocative inefficiency, is unknown. Thus, $\overline{AE}$ is given by dividing the cost by the remaining components, that is, $\overline{AE}_i=\frac{\hat{C}_i}{Ar_i^{\frac{\beta 1}{\beta}}w_i^{\frac{\beta 2}{\beta}}\hat{Y}_i^{\frac{1}{\beta}}TE_i^{\frac{-1}{\beta}}}$. From the definition, η is given by dividing C by $\hat{C}$. With this information, the difference of the unit costs of two firms can be decomposed to factor prices, scale economies and inefficiencies.

It should be noted that the difference of wages between Kenyan and Bangladeshi firms may reflect the difference of workers' skill as well as wage levels of the country. In order to understand the impact of wage levels on competitiveness, the skill effect should be controlled. We make simple assumption that wages are determined only by skill and the wage level of a country, and that purchasing power parity for consumption goods represents the wage level. Then, wages can be described as,

$$\frac{w_i}{w_j}=\frac{PPP_l}{PPP_m}*\frac{w_i/PPP_l}{w_j/PPP_m},$$

where PPP_l is the purchasing power parity of currency of the country *l*. The first part of the right hand side reflects the difference of the wage level represented by PPP, while the second part represents the skill component. To see the validity of this assumption, impact of the skill component

[4] This decomposition is structurally equivalent to that in Nishimizu and Page [1986], although they have used deterministic approach and applied to time series data.

on technical efficiency is tested. Following the method by Kumbhakar, Gosh and McGuckin [1991], an exogenous variable is assumed to be correlated with u through the mode of inefficiency, μ.

$$\begin{aligned} \ln Yi &= \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i - u_i + v_i \\ \mu_i &= \eta_0 + \eta_1 ws_i \end{aligned} , \qquad (5)$$

where $u_i \sim N^+ (\mu_i, \sigma_u)$, $v_i \sim N(0, \sigma_v)$ and ws_i is the skill component of wage. If ws_i has a significant negative correlation with μ, then the use of PPP is justified.

2.3 Data

Firm data were collected in Bangladesh and Kenya in 2003 under the UNIDO COMPID project. The sample was drawn from firms with more than 10 employees, and the data consist of 222 firms in Bangladesh and 71 firms in Kenya among (see Appendix 1 for the sampling method). The number of samples reflects the size of industry, where the Bangladeshi industry has more then 2000 firms and the Kenyan industry is estimated to have 120-150 firms[5]. The textile industry was not included, because it has more capital-intensive technology than the garment industry and the essential assumption for consistent frontier estimation that sample firms share the same technology may not be reasonable. Measurement errors are found particularly in output and input values in some samples. Since outliers seriously affect precision of the estimated frontier function, samples that have unrealistic inputs and output values were dropped[6]. Excluding also the samples that have no information about input and output values, consequently, 165 sample in Bangladesh and 47 in Kenya were retained for analysis.

Output values were collected in local currency. Although purchasing power parity (PPP) is the standard instrument for converting value in local currency to quantity index utilizing it as an international price deflator, we have used exchange rate instead of PPP because of the following reasons. All products of Bangladeshi firms and multinational firms in Kenya are exported and priced in US or EU markets, and thus, conversion by exchange rate is appropriate. On the other hand, most Kenyan local firms supply to the domestic market, but comparisons of prices in the Kenyan and US/EU markets showed that exchange rate is more consistent international price deflator than PPP[7]. Since the exchange rate gives a higher price to Kenyan products than the PPP, deflation by the exchange rate leads to a smaller output quantity index of Kenyan local firms, and results in lower technical efficiency estimates than deflation by the PPP.

Capital value and the number of employees are used as inputs, where capital value is constructed using the perpetual inventory method and converted by the exchange rate[8]. Use of the exchange rate is reasonable provided that all equipment is imported in both countries.

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[5] Estimation by the author for the firms employing more than 10 employees.
[6] See Appendix 1 for detail of the sample restriction.
[7] See Appendix 1 regarding choice of an international price deflator.
[8] See appendix for detail of capital value construction.

Regarding factor prices, wages are obtained as labour costs per worker, while capital rental price is not explicitly observable, and were estimated using the following method. Assuming all investments yield the same rate of return and perfect foresight, the arbitrage condition is

$$R_i = r_{i,t} p_{i,t} - \delta p_{i,t} + (p_{i,t+1} - p_{i,t}),$$

where R: rate of return (real interest rate), δ: depreciation rate, and p_t: asset price of capital at t. Since all firms have used imported equipment, it is assumed that asset prices are same for all samples, $p_i = p$. Arranging the arbitrage condition, rental price is given as

$$r_{i,t} = \left(R_i + \delta - \frac{p_{t+1} - p_t}{p_t} \right) p_t . \qquad (6)$$

The real interest rates of Kenya and Bangladesh were obtained from World Development Indicators, although they are not suitable for multinational firms which normally finance investment in other countries. Then, the real interest rate of India where many of them originate was used. The asset price change was calculated from the US deflator, and thus it is common to all observations. Although we do not have an appropriate value for asset price, p_t, it is constant for all observations, and thus, we normalized it as p_t=1. Consequently, the rental price of capital varies with nationality of a firm and does not consider individual price variation according to, for example, credit constraint. This may cause downward bias in estimation of allocative efficiency for firms suffering severe credit constraint (these firms may be misestimated as less efficient than actual).

Capital service cost was also estimated. From (6), capital service cost is $r_t K_t = (R + \delta - (p_{t+1} - p_t)/p_t) p_t K_t$, where $p_t K_t$ is capital value. Using the real interest rate, depreciation rate, equipment price change rate, and capital value, service cost can be estimated. The capital service cost is estimated only for equipment because data of asset prices of land and buildings was not available.

3. Empirical Analysis

3.1 Overview of the Statistics

Reflecting the strong export orientation of the Bangladeshi garment industry, all Bangladeshi samples are exporting their products to the US and/or EU markets. On the other hand, only seven firms export to those markets in the Kenyan samples and the rest supply to the domestic or African markets. Major exporters are multinational firms established after 2000, and they are registered as an Export Processing Zone (EPZ) firm in order to utilize the advantages of AGOA which provides preferential access to the US market from sub-Saharan Africa. 35 EPZ firms were in operation at the time of the survey, of which five firms are included in the sample. Growth of exports was so rapid that production for the US market has far exceeded that for the domestic market, but local firms in Kenya have not responded to the export boom and remained in the domestic market with a few exceptions.

Basic production statistics of sample firms are described in Table A. It shows that on average, Bangladeshi firms are about five times larger than Kenyan local firms in production, while Kenyan EPZ firms are the largest among the three groups. In terms of inputs, Kenyan firms are more capital intensive than Bangladeshi firms on average, partly because of the lower utilization rate of equipment. After adjusting the utilization rate, however, Kenyan firms still appear more capital intensive than Bangladeshi firms, and this is consistent with the relative factor prices as we will see later. It also indicates that Bangladeshi firms are highly profitable; the average share of profit to value added is about 70%, while the profit share of Kenyan firms, including EPZ firms, is much less.

From the author's field observation, the production system appears different between Kenyan local firms (non-exporters) and other firms (exporters) in two aspects. Exporters to US/EU markets have highly disaggregated assembly lines where machine operators specialize in small tasks, while Kenyan local firms have less disaggregated process, or sometimes no assembly line in the sewing process. In such cases, one operator sews a whole product. Secondly, the number of floor-level workers per sewing machine in Kenyan local firms is less than that of exporting firms. This means that they allocate fewer helpers to assembly lines, and thus, operators in a Kenyan local firm have to cover a wider range of processes than those in an exporting firm[9]. Conversely, Kenyan EPZ firms maintain a highly disaggregated assembly line despite fewer workers, where labour is substituted by new and high-tech equipment (i.e. specialized and computerized sewing machine).

Table B indicates cost statistics. Unit cost is defined as capital and labour service costs per value added, and capital service cost includes only equipment. The average unit cost of a Kenyan local firm is 2.46 times higher than that of Bangladeshi firms. It is partly explained by the labour cost per worker, given that the labour cost in Kenyan local firms is 2.84 times higher, while the rental price and average labour productivity is almost the same between the two groups.

Statistics show that due to relatively high wages, Kenyan firms have employed more capital and less labour than their Bangladeshi counterparts, but capital intensity does not raise labour productivity enough to cancel the high labour cost. Then, their unit costs on average remain high. Simple statistics, however, do not indicate why labour productivity has remained relatively low. It can be attributed to misallocation of inputs (too little capital), inefficient production, or smaller size of Kenyan local firms in the case of increasing returns to scale. The sources of the unit cost difference will be approached in the next sections.

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[9] The average number of floor-level workers per sewing machine is 1.78 for Bangladeshi firms, 1.13 for Kenyan local and 1.47 for EPZ firms (the number of sewing machines is adjusted by the utilization rate and workers are restricted to those working in sewing section so that the figure reflects the production characteristics in sewing process).

3.2 Measurement of Technical Efficiency

The main production activity in the garment assembly process includes two different types of work; sewing and knitting. While woven garments such as woven shirts and trousers are made by only a sewing process, knitting garments like T-shirts and sweater are made by a knitting process and occasionally a sewing process. The technology of the two processes differs, and thus a dummy variable, *grp*, is included in the estimation model to distinguish the firms with a sewing process from those who have an only knitting process.

The benchmark model using value added as output and assuming a half normal distribution for inefficiency, u, has yielded all significant coefficients including variance of u and v, σ_u, and σ_v, at 5% level (Model 1 in Table C). The estimated production function shows slightly increasing returns to scale, and constant returns scale is rejected. To see whether all samples share the same technology, in particular between Kenyan local firms and the rest of firms, separate functions were estimated. Model 2 includes interaction terms with the dummy for Kenyan local firms (*kld*) as well as the dummy variable itself. The interaction terms and the dummy are not statistically significant at 5%, but the interaction term with labour ($\ln L*kld$) is significant at 10%. Although the null hypothesis that two groups have different technology cannot be rejected completely, the estimate has indicats that they are more likely to share the same technology, and Bangladeshi firms are more labour intensive than Kenyan firms.

Based on Model 1, heteroskedasticity was tested using the Breush-Pagan test, White's General test, and Goldfield-Quandt test, in which group wise heteroskedasticity between Kenyan local and the rest of firms is assumed. All tests have indicated that the null hypothesis of homoskedasticity could not be rejected at 5% level, while Goldfield-Quandt test rejected the null at 10% level. Then, the auxiliary models are added to estimate σ_{ui} and σ_{vi} by dummy variable, as $\sigma_{ui}=\exp(\delta_1 (1, kld_i))$ and/or $\sigma_{vi}=\exp(\delta_2 (1, kld_i))$. But they were not significant at 10% level (the result is not reported).

Then, the assumption of a half normal distribution of u was replace by a truncated normal distribution that allows a mode of distribution having any positive values (Model 3). The result is quite similar to the benchmarked model, and σ_u and the mode of u, μ, are not significantly differ from zero. That is, there is no statistical support for a truncated normal distribution. Finally the production function was estimated using gross output instead of value added as a dependent variable (Model 4). Subcontractors that do not purchase material were excluded. This yielded similar results to the benchmarked model, and so use of value added does not seem to cause serious bias in estimation.

The averages of technical efficiency are between 0.515 and 0.641, where the benchmarked model has yielded the lowest average. Group averages of the technical efficiency obtained by Model 1, 3, and 4 are listed in Table D (the result of model 2 was omitted because it is not based on a common production frontier). The Kenyan sample is divided into local firms and EPZ firms considering heterogeneity of characteristics, although the average of EPZ firms was less reliable due to small sample size. Comparison demonstrated that the group average of Bangladeshi firms is slightly higher than that of Kenyan local firms in Model 1 and 4 but it is lower in Model 3, and the difference is not statistically significant at 10% in all three models. In terms of transformation of input to output, Kenyan local firms are on average not significantly less efficient than the Bangladeshi firms that have been competitive in the US and EU markets for more than a decade[10].

Though the production system with short or no assembly line appears less technologically sophisticated, the estimation of production frontier function suggests that they are technologically equivalent. This seems reasonable because a short assembly line is more efficient when production scale is small. A short assembly line may have another merit under a high wage-rental ratio, which it requires less number of helpers. A long assembly line needs substantial number of helpers to synchronize the pace of all steps. Consequently, operators in Kenyan local firms need to have multitasking capacity to deal with several processes. That is, labour is substituted for by machines and skills of workers. Conversely, in Kenyan EPZ firms, a long assembly line is suitable for mass-production and it is maintained by installing high-tech machines. Although both Kenyan local and EPZ firms have capital-intensive production system, they differ in the role of workers; workers do multitask to make up for the fewer labour in local firms, while workers remain in single tasks due to the support of high-tech equipment.

Estimation also indicates that the technical efficiency of firms participating in the global production network is not significantly higher than those not participating. This result appears to be inconsistent with the literatures of FDI spillover and global value chains that assume technological advantage of the firms in global production network. In the case of the garment industry, participation in the global production network requires expansion of production scale under the same production function, but the production system for exporting is not technologically more sophisticated. Thus, the result implies that there is no advantage for exporters. However, the two production systems significantly differ in management, and so, switch of the system is not costless process. From the author’s field interviews, it appears that local firms attempting to enter the export market have learned the design of production lines, quality control, sewing skills, and market linkages from EPZ firms and expatriates. Participation in the global production network needs substantial learning by firms as argued in the literature of FDI spillover and global value chain. Our results indicate that Kenyan local firms manage their production just as well as Bangladeshi exporters, but they do not imply that Kenyan firms are capable to supply for the export market without learning.

[10] The relationship between efficiency (technical and allocative) and characteristics of firms in the Kenyan sample is described in the Appendix 3.

Results also showed that the learning-by-exporting effect is absent, which is indicated in the several firm studies (for example, Bigsten et al. [2000]). This seems natural from the above technological account, because learning-by-exporting works only when a firm is attempting to switch from a domestic to an export market.

3.2 Decomposition of Unit Cost Difference

The cost of allocative inefficiency, $\overline{AE}$, is calculated based on the estimation by Model 1. Table E shows that allocative inefficiency inflates costs by 13.7% for Bangladeshi firms, while it has greater impact (33.0%) on costs for Kenyan local firms. The difference of the averages is significant at 1 % level. Costs of unused capital are also larger for Kenyan local firms; due to low utilization rate they paid 2.5% of total cost on average, while Bangladeshi firms incurred only 0.2%. Multiplying the two components yields the total cost of allocative inefficiency reported in the last column. On average, allocative inefficiency added 14.0% of costs to the minimized cost for Bangladeshi firms, and it added 36.3% for Kenyan local firms. In terms of allocation of capital and labour, Kenyan local firms are significantly less efficient and incur substantial cost increases.

Based on the estimates of technical efficiency, allocative efficiency, and parameters of the cost function, unit cost difference and its decomposition are estimated from the Equation (4). The first column of Table F shows the estimations of each component of (4) based on the mean values of Bangladeshi and Kenyan local firms, benchmarking on Bangladeshi mean (it is a denominator). It indicates that the mean unit cost of Kenyan locals is 2.93 times higher than that of Bangladeshi firms[11]. The following figures in the table are contribution of factor prices, scale economies and efficiencies and if it is greater (smaller) than one, the component contributes to increase (decrease) the unit cost of Kenyan local firms relative to Bangladeshi firms. The difference in wages between the two groups makes the greatest contribution, inflating Kenyan unit cost by 137.7%, while rental prices and scale economies yield little difference; 1.3% decrease and 4.1% increase respectively. With respect to inefficiencies, the difference of technical inefficiency between the two groups makes a small contribution (0.41% increase), whereas allocative inefficiency increases the unit cost of Kenyan local firms by 16.9%. The comparison based on the average demonstrates that the large gap of unit cost between the two groups due to the difference in wages and to a much lesser extent, by allocative inefficiency.

Kenyan local firms are separated to two groups according to unit cost (lower 50% and upper 50%)

[11] This figure does not corresponded exactly with the ratio of average unit costs obtained from Table B. This is because the figure in Table F is calculated from mean factor prices, scale economy, and efficiencies of Bangladeshi and Kenyan local firms, while the figures in Table B are simply the average of unit costs. The figure in Table F indicates the difference of unit costs between the hypothetical average Kenyan and Bangladeshi firms endowed with average characteristics.

and compared with the Bangladeshi mean respectively (the second and the third columns of Table F and Figure B). The lower 50% of firms (better performers) outperform Bangladeshi competitors with respect to technical efficiency, but they are less efficient in terms of allocation of inputs. Integrating both efficiencies, they are almost as efficient as the Bangladeshi mean (TE*AE=1.033), though their unit cost is 2.05 times higher. Comparing the two groups, we have found that the lower 50% group produces at half cost of the upper 50% group, and such low cost is realized through higher technical and allocative efficiency as well as lower wages.

Wage levels partly reflect skill of workers, so the contribution of wages estimated above includes differences in skills. To rule out the skill effect on wages, it is separated into price level and a skill component by using PPP. The ratio of the price level of Kenya to Bangladesh is 2.32, and its contribution to the unit cost is 1.916, which is smaller than the estimate without controlling skill (Table G). Then, the correlation of the skill component is estimated using (5), and the result is described in the last column of Table C. Considering heterogeneity in marginal returns to skill in the two countries, the interaction term with the country dummy (*ws***kd*) was added. Although the interaction term is not significant, the skill component itself is significant and has a right sign; higher skill component is correlated with lower inefficiency. The use of PPP seems reasonable. Thus, even controlling skill, wages still make the largest contribution to the difference of unit costs between Kenyan local and Bangladeshi firms.

This finding is consistent with the fact that most Kenyan local firms pay more than the minimum wage, while the wage of EPZ firms is near the minimum. The minimum wage in Kenya was 5090 Kenya Shillings (about US$67) per month for an operator in 2003, while the average of Kenyan local firms was 7207 KSh (about US$95) (Fukunishi et al [2006: Table 14]). Wages are particularly high in firms with no assembly line; the average wage of operator of a firm with no assembly line is 26.5% higher than one with an assembly line. As mentioned, an operator needs to deal with more tasks in a short assembly line. Thus, local firms are not able to employ workers at the minimum wage without sacrificing efficiency, while EPZ firms with long assembly line can do so.

The positive correlation between skills and wages, and between skills and technical efficiency, implies that attempts by a Kenyan firm to improve efficiency by raising the skill of workers will lead to wage increases, and the effect of such attempts on cost reduction is partly offset. This may discourage local firms from competing with imports by improving efficiency.

4. Conclusion

It has been argued that African firms have performed lower productivity than firms in other developing countries, and it is a critical source of weak competitiveness under globalization. A comparison of Kenyan local firms with Bangladeshi firms in the garment industry indicates that Kenyan local firms operate almost as efficiently as Bangladeshi firms on average in terms of transforming input to output, despite conservative estimates. This is notable because Kenyan local firms have little experience in the US/EU markets while Bangladeshi firms have been successfully competing in the world market for decades.

However, a large gap between the two groups was found in price competitiveness measured as unit cost; the unit cost of Kenyan local firms was 2.5 times greater on average. The difference of average unit costs was decomposed based on the production frontier estimation. It revealed that the difference of wages between the two groups has contributed most of the unit cost difference, and the difference of allocative inefficiency makes the second largest contribution but much smaller. The contributions of technical inefficiency, scale economy, and rental price are all small. Kenyan local firms incur higher unit cost primarily due to higher wages, and the inefficiency of technological management makes a minor contribution.

Although poor productivity has been noted in the literatures studying African manufacturing sector, comparisons in the garment industry show that the productivity difference between Kenyan firms and the successful exporters is not as much as noted, and it has relatively small contribution to their competitiveness. Although this result cannot be generalized to other industries without further consideration, it indicates that the focus on the factor prices is important in investigations of the stagnate performance of the African manufacturing sector.

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Table A Average Output and Input by Group

	Gross output (1000US$)	Value added (1000US$)	Number of workers	Capital value (1000US$)	Utilized capital value / worker	Profit/ VA	N
Bangladeshi Firms	2977.7 (2247.7)	1554.1 (1261.5)	535.2 (250.7)	121.1 (85.1)	372.4 (289.4)	0.715 (0.228)	165
Kenyan Local Firms	549.8 (1115.5)	261.5 (720.3)	78.5 (161.5)	45.2 (91.0)	428.2 (475.6)	0.252 (0.502)	42
Kenyan EPZ Firms	13800.0 (21100.0)	8739.4 (15100.0)	892.4 (376.9)	716.8 (809.8)	618.6 (575.5)	0.481 (0.486)	5

Note: Standard deviations are in parentheses.

Table B Average Cost and Labour Productivity by Group

	Unit Cost	Labour cost per worker (US$)	Rental price (estimated)	Labour productivity
Bangladeshi Firms	0.266 (0.220)	469.0 (225.6)	0.184	3099.6 (2270.6)
Kenyan Local Firms	0.655 (0.437)	1330.5 (688.3)	0.171	3035.7 (2855.2)
Kenyan EPZ Firms	0.620 (0.606)	1064.7 (432.6)	0.144	9556.9 (16935.9)

Note: Standard deviations are in parentheses.

Table C Results of Estimation of the Production Function

Model	1	2	3	4	5
Dependent Variable	Value added	Value added	Value added	Gross output	Value added
Distribution of u	Half normal	Half normal	Truncated normal	Half normal	Truncated normal
lnK	0.173*	0.238*	0.169*	0.163*	0.110
	(0.076)	(0.099)	(0.074)	(0.067)	(0.072)
lnL	0.849**	0.666**	0.860**	0.819**	0.907**
	(0.087)	(0.151)	(0.085)	(0.074)	(0.091)
grp	0.342*	0.358*	0.374**	0.401**	0.405**
	(0.134)	(0.140)	(0.131)	(0.113)	(0.118)
lnK*kld		-0.198			
		(0.156)			
lnL*kld		0.372			
		(0.226)			
kld		0.094			
		(1.271)			
cons	7.271**	7.646**	7.059**	7.987**	7.311**
	(0.496)	(1.132)	(0.488)	(0.458)	(0.487)
σ_v	0.503	0.502		0.492	
	(0.067)	(0.065)		(0.063)	
σ_u	1.046	1.035		0.642	
	(0.119)	(0.115)		(0.140)	
σ_v^2			4.787		0.714
			(10.496)		(0.383)
σ_u^2			0.291		0.316
			(0.075)		(0.064)
$\sigma^2=\sigma_v^2+\sigma_u^2$	1.346	1.323	5.077	0.655	1.029
	(0.209)	(0.203)	(10.526)	(0.136)	(0.365)
$\lambda=\sigma_u/\sigma_v$	2.078	2.060		1.304	
	(0.171)	(0.165)		(0.194)	
$\gamma=\sigma_u^2/\sigma^2$			0.943		0.693
			(0.114)		(0.136)
μ			-6.095		
			(17.218)		
Dependent Var: μ					
ws					-0.002*
					(0.001)
ws*kd					0.0004
					(0.0003)
cons					3.082**
					(0.721)
Constant Returns to Scale:	0.28	--	0.49	0.25	
χ^2 stat and pvalue	[0.599]	--	[0.482]	[0.620]	
Average Technical	0.515	0.519	0.598	0.641	
Efficiency	(0.187)	(0.185)	(0.184)	(0.127)	
N	212	212	212	195	212

Note: Standard errors are in parentheses. P-values for the test of constant returns to scale are in square brackets. * and ** indicate that coefficient is significantly different from zero at respectively 5% and 1% levels.

Table D Average Technical Efficiency by Group

Model	1	3	4
Bangladeshi Firms	0.516 (0.189) [165]	0.598 (0.188) [165]	0.645 (0.127) [152]
Kenyan Local Firms	0.514 (0.170) [42]	0.605 (0.161) [42]	0.636 (0.128) [40]
Kenyan EPZ Firms	0.486 (0.278) [5]	0.555 (0.259) [5]	0.545 (0.107) [5]

Note: Standard deviations are in parentheses, and sample sizes are in square brackets.

Table E Average Cost of Allocative Efficiency by Group

	Utilized inputs ($\overline{AE}$)	Idle capital (η)	Total AE (= $\overline{AE}$ *η)
Bangladeshi Firms (N=165)	1.137 (0.065)	1.002 (0.005)	1.140
Kenyan Local Firms (N=42)	1.330 (0.280)	1.025 (0.054)	1.363
Kenyan EPZ Firms (N=5)	1.209 (0.139)	1.008 (0.008)	1.219

Note: Standard deviations are in parentheses.

Table F Decomposition of the Difference of Unit Cost

		Kenyan mean / Bangladeshi mean	Mean of lower 50% / Bangladeshi mean	Mean of upper 50% / Bangladeshi mean
Unit cost (a)	D_i/D_j	2.932	2.045	4.090
Rental price (b)	$(r_i/r_j)^{\beta 1/\beta}$	0.988	0.988	0.988
Wage (c)	$(w_i/w_j)^{\beta 2/\beta}$	2.377	1.944	2.795
Scale Economy (d)	$(Y_i/Y_j)^{1/\beta-1}$	1.041	1.032	1.057
Technical Inefficiency (e)	$(TE_i/TE_j)^{-1/\beta}$	1.004	0.922	1.102
Allocative Inefficiency (f)	$AE_i\eta_i/AE_j\eta_j$	1.169	1.120	1.272

Note: As indicated by the equation (4), a=b*c*d*e*f.

Table G Contribution of Wage to Unit Cost Controlling Skill

	Kenyan mean / Bangladeshi mean
Wage Controlling Skill	1.916
Skill Component	1.241
Wage not Controlling Skill	2.377

Figure A　Cost of Technical and Allocative Inefficiency

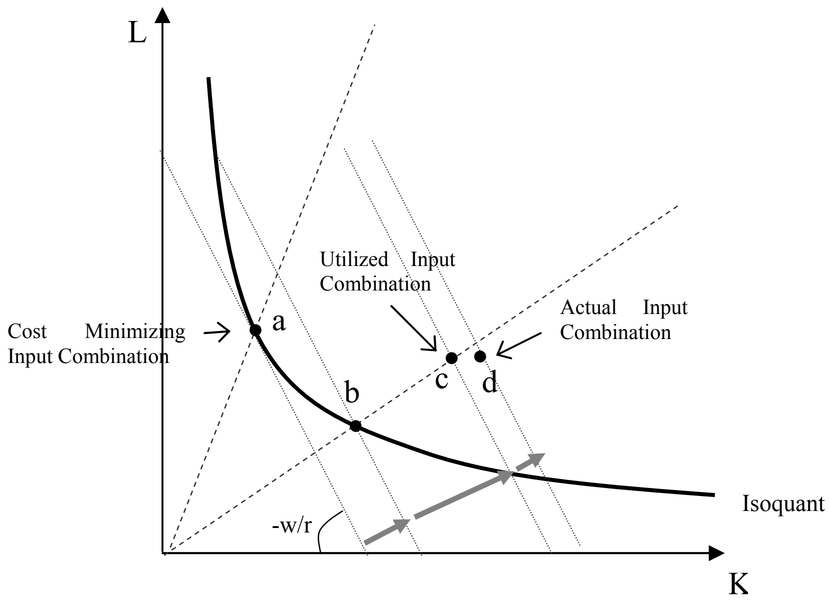
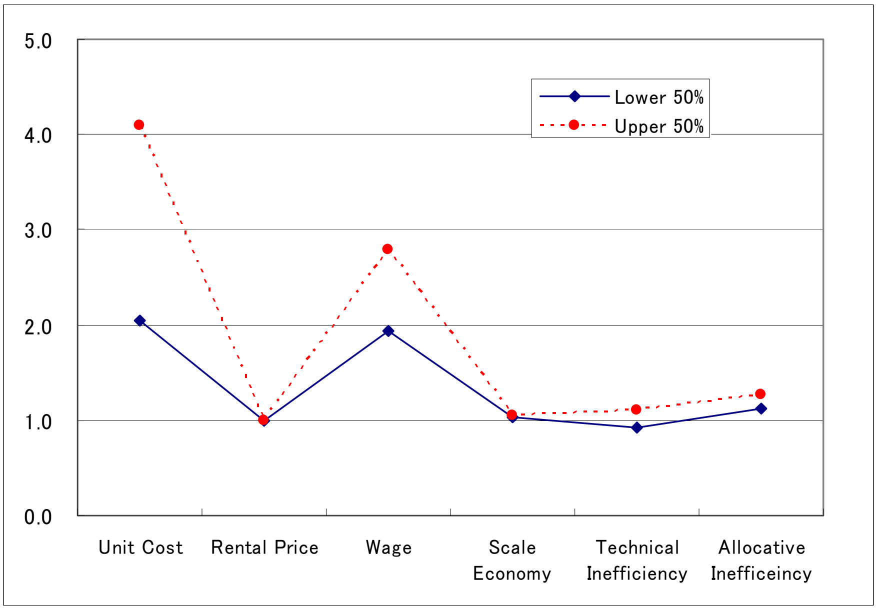


Figure B　Comparison of Contribution to Unit Cost for the Two Groups of Kenyan Local Firms



Note: Ratios to the Bangladeshi means. See text for the grouping of samples.

Appendix 1: Sampling Method and Data Construction

1. Sampling Method

Firm surveys were jointly conducted with the Institute of Developing Economies, the Institute of Development Studies, University of Nairobi, and the Institute of Business Administration, University of Dhaka in 2003.

The Kenya survey began with construction of a firm list since there is no comprehensive firm list. Integrating several incomplete lists, including lists compiled by the Central Bureau of Statistics, the Investment Promotion Center, the Export Processing Zones Authority, the Kenyan Association of Manufacturers and the Institute of Development Studies, an extensive firm list containing 322 firms with more than 10 employees in Nairobi, Mombasa, Nakuru, Thika and Eldoret was constructed. Because this list includes firms that had closed down, all firms in the list were contacted and interviews were conducted with those still in operation. They survey collected information of 71 firms out of 104 firms in operation. Neither the population nor characteristics of the remaining 33 firms were known, it is difficult to determine whether our samples have bias or not except that responses from EPZ firm were less than other firms.

In the Bangladesh survey, samples were selected from the member list of the Bangladesh Garment Manufacturers and Exporters Association (BGMA) using a stratified sampling method. Another industrial association, the Bangladesh Knitwear Manufacturers and Exporters Association (BKMEA), which is mainly constituted by knit wear producers, was not included in order to retain accordance with the Kenyan sample that was mainly composed of woven wear producers. Among 2891 members, data was collected from 222 firms. For detail of the sampling procedure, see Fukunishi et al. [2006].

2. Sample Restriction

Some samples did not have complete information regarding input and output, particularly in Kenyan sample, due to lack of capital inventory. Only 248 firms out of 293 have full information. Among these, the samples with incorrect information were also excluded. That is, firms with negative value added, unrealistic labour costs per worker, capital value per worker, or share of labour costs in value added were eliminated. The latter three restrictions were imposed based on our belief that number of workers is the most reliable information, and they exclude the samples with unrealistic wages, capital value, and output considering number of workers. Specific restrictions were that labour cost per worker be from US$100 to $2000 for Bangladesh and from $500 to $5000 for Kenya, that capital value per worker be below $5000, and that the share of wage bill in value added be greater than 4%. Incorrect data was seen primarily in the Bangladeshi samples. Excluding these firms, 212 firms (165 Bangladeshi firms and 47 Kenyan firms) were remained in the sample. It should be noted that without the restrictions on labour cost per worker and wage share in value added, the similar results was obtained, and in particular the key finding that average technical efficiency does not significantly differ between Bangladeshi and Kenyan local firms was retained.

Through the restrictions, large firms were more likely to be dropped from the sample, and thus the sample selection problem may be significant.

3. Capital Value Construction

Only the value of equipment was constructed using the perpetual inventory method. For some Kenyan samples with incomplete capital purchase price data, capital value was estimated from resale value data. For deflation, an US deflator (price indexes for 'Special industry machinery' issued by Bureau of Economic Analysis) was used for both Kenya and Bangladeshi samples after capital value was converted to US dollars by the exchange rate. Use of the US deflator is reasonable given that almost all capital equipment was imported. Depreciation rate is set to 10% based on a comparison of constructed capital value with resale value among the Kenyan samples.

4. International Price Deflator

The data of input and output values is in local currency and need to be converted to quantity when used for production function. Given the diversity of equipment and products, quantity of capital and output is not usually given in a consistent way. Then, a quantity index is normally used, where it is given by dividing value by a price deflator. For imported input (capital equipments) and exported products which are priced in OECD countries, exchange rate from local currency to US dollar is an appropriate price deflator as long as the price levels in OECD countries are similar. All Bangladeshi firms and Kenyan EPZ firms export products to US/EU markets, and all sample firms use imported equipment.

For output sold in the domestic market, purchasing power parity is a standard international price deflator. The PPP rate of Kenyan Shilling to US dollar for consumption goods is 27.59Ksh, while the exchange rate is 75.94Ksh (2003, Penn World Tables). This means that at the exchange rate-converted price, the same goods cost about three times more in US than in Kenya, but the average producer prices of T-shirts, men's shirts and trousers in the Kenyan market are not lower than those for the export market (mainly the US market) at the exchange rate-converted price, despite the relatively low quality of Kenyan products. Therefore, the PPP rate may undervalues Kenyan products, and consequently leads to overestimation of the quantity index of Kenyan local firms supplying the domestic market. To avoid bias, the exchange rate was used as a price deflator. Estimates of technical efficiency of Kenyan local firms tend to be smaller than estimates based on the PPP-converted quantity index.

Appendix 2: Likelihood Functions and Estimation of u_i

The inefficiency term u in equation (2) has the density function as follows:

$f(u) = \frac{2}{\sqrt{2\pi}\sigma_u} \cdot \exp\left\{-\frac{u^2}{2\sigma_u^2}\right\}$ when u is assumed to follow a half normal distribution, and

$f(u) = \frac{2}{\sqrt{2\pi}\sigma_u} \cdot \exp\left\{-\frac{u^2}{2\sigma_u^2}\right\}$ when u is assumed to follow a truncated normal distribution.

The density of v is

$$f(v) = \frac{1}{\sqrt{2\pi}\sigma_v} \cdot \exp\left\{-\frac{v^2}{2\sigma_v^2}\right\}.$$

The joint density function of u and v provides the joint density of u and ε, given $\varepsilon=-u+v$. Then, by integrating u out of $f(u, \varepsilon)$, the marginal density function of ε is

$$f(\varepsilon) = \int_o^\infty \frac{2}{2\pi\sigma_u\sigma_v} \cdot \exp\left\{-\frac{u^2}{2\sigma_u^2} - \frac{(\varepsilon+u)^2}{2\sigma_v^2}\right\} du$$
$$= \frac{2}{\sqrt{2\pi}\sigma} \cdot \left[1 - \Phi\left(\frac{\varepsilon\lambda}{\sigma}\right)\right] \cdot \exp\left(-\frac{\varepsilon^2}{2\sigma^2}\right) \cdot$$

given a half normal distribution, and

$$f(\varepsilon) = \int_o^\infty \frac{1}{2\pi\sigma_u\sigma_v\Phi(-\mu/\sigma_u)} \cdot \exp\left\{-\frac{(u-\mu)^2}{2\sigma_u^2} - \frac{(\varepsilon+u)^2}{2\sigma_v^2}\right\} du$$
$$= \frac{1}{\sqrt{2\pi}\sigma\Phi(-\mu/\sigma_u)} \cdot \Phi\left(\frac{\mu}{\sigma\lambda} - \frac{\varepsilon\lambda}{\sigma}\right) \cdot \exp\left(-\frac{(\varepsilon+\mu)^2}{2\sigma^2}\right)$$

given a truncated normal distribution, where $\sigma=(\sigma_u^2+\sigma_v^2)^{1/2}$, $\lambda=\sigma_u/\sigma_v$, and $\Phi(.)$ is the standard normal cumulative distribution function.

Then log-likelihood functions for N observations are,

$$\ln L = \sum_i^N \left\{-\frac{1}{2}\ln(2\pi) - \ln\sigma + \ln\Phi\left(-\frac{\varepsilon_i\lambda}{\sigma}\right) - \frac{\varepsilon_i^2}{2\sigma^2}\right\}$$

given a half normal distribution, and

$$\ln L = \sum_i^N \left\{-\frac{1}{2}\ln(2\pi) - \ln\sigma - \ln\Phi\left(\frac{\mu}{\sigma\gamma^{1/2}}\right) + \ln\Phi\left(\frac{\mu(1-\gamma) - \varepsilon_i\gamma}{\left[\sigma^2\gamma(1-\gamma)\right]^{1/2}}\right) - \frac{1}{2}\left(\frac{\varepsilon_i+\mu}{\sigma}\right)^2\right\}$$

given a truncated normal distribution, where $\gamma=\sigma_u^2/\sigma^2$.

The inefficiency of an individual firm i, u_i, is included in the regression residual, ε_i, and not visible. However, it can be estimated from the conditional distribution of u_i given ε_i. Jondrow et al [1982] showed that if $u_i \sim N^+(0, \sigma_u)$, then the conditional distribution is

$$f(u \mid \varepsilon) = \frac{1}{\sqrt{2\pi}\sigma'} \cdot \exp\left\{-\frac{(u+\varepsilon\gamma)^2}{2\sigma'^2}\right\} \bigg/ \left[1-\Phi\left(\frac{\varepsilon\gamma}{\sigma'}\right)\right],$$

where $\sigma'=\sigma_u^2\sigma_v^2/\sigma^2$. The expected value of u_i conditional on ε_i was used for technical efficiency, which is given by

$$E[u_i \mid \varepsilon_i] = \sigma'\left[\frac{\phi(\varepsilon_i\lambda/\sigma')}{1-\Phi(\varepsilon_i\lambda/\sigma')} - \left(\frac{\varepsilon_i\lambda}{\sigma'}\right)\right].$$

$$TE_i = \exp(-E[u_i \mid \varepsilon_i])$$

For the truncated normal model,

$$f(u \mid \varepsilon) = \frac{1}{\sqrt{2\pi}\sigma'} \cdot \exp\left\{-\frac{(u-\gamma')^2}{2\sigma'^2}\right\} \bigg/ \left[1-\Phi\left(-\frac{\gamma'}{\sigma'}\right)\right],$$

$$E[u_i \mid \varepsilon_i] = \sigma'\left[\frac{\phi(\gamma_i'/\sigma')}{1-\Phi(\gamma_i'/\sigma')} - \left(\frac{\gamma_i'}{\sigma'}\right)\right]$$

where $\gamma'=(-\varepsilon\sigma_u^2+\mu\sigma_v^2)/\sigma^2$.

Appendix3: Efficiency by Firm Characteristics in the Kenyan Sample

The mean technical efficiency (*TEi*) and cost of allocative inefficiency including unused capital ($\overline{AE_i}$ *η_i) are described by the characteristics of firms in Table A1. As the sample size is small for several groups, geometric mean which is more robust for outliers was also calculated.

Several studies have indicated that exporters show higher technical efficiency than non-exporters, regardless of direction of causality (for example, Bigsten et al [2000], Mazumdar and Mazaheri [2003: ch10]), but this is not supported by our data. Although the average TE of exporters is higher than that of non-exporters, the difference is not significant, and the geometric mean indicates an opposite relationship. The cost of allocative inefficiency shows a little clearer distinction; both the arithmetic and geometric means are higher for non-exporters, and it implies that exporters are more efficient in input allocation, though difference is not significant.

In Kenya, as in the other African countries, the manufacturing sector and commercial sector have been dominated by Asian Kenyan entrepreneurs, and firm networks are formed based on the ethnicity of managers. Studies have demonstrated that non-African managers are more likely to do business and to exchange information with non-African owned firms (Fafchamps [2000] [2001]). Several studies have found that the firms with non-African manager are more productive than those with African manager (Biggs et al. [1995], Lundvall, Ochoro and Hjalmarsson [2002]). In our sample, while there was no significant difference in technical efficiency between African and non-African firms, the cost of allocative inefficiency was significantly lower for non-African firms (at 5% level).

Relationship between firm size and efficiency is ambiguous in the literature. In the study sample, there seems to be an U-shaped relationship, where middle size firms are less efficient than small and large firms, though the difference is not significant. On the contrary, there is a clear trend for the cost of allocative inefficiency; as the firm size is larger, the cost of allocative inefficiency is smaller. Large firms are more efficient in allocation of inputs, but not so in transformation of inputs to output.

The largest clusters of garment firms are in Nairobi, and clusters may have a positive effect on efficiency if they facilitate flow of information and human capital. In the Kenyan sample, however technical efficiency dis not show a clear difference between the firms in Nairobi and those outside of the capital. Cost allocative inefficiency indicated an opposite relationship: firms in Nairobi have higher cost on average.

Overall, allocative efficiency is more correlated with the characteristics of firms than technical efficiency is. Firms exporting to US/EU markets, those with non-African managers, those with larger sizes, or those located outside of Nairobi, tend to be more efficient in input allocation. This is an association rather than a causation given relationships among the characteristics and possible reverse causation of some characteristics with the dependent variable. For example, non-African firms tend to be larger and have a higher share of exporters, and efficient firms are more likely to enter into the export market.

Table A1 Mean Technical Efficiency and Cost of Allocative Inefficiency by Characteristics of Firms

		Technical Efficiency	Cost of Allocative Inefficiency and Unused Capital
Output Market	Exporting Firm (N=7)	0.523	1.295
		[0.243]	[0.218]
		0.467	*1.281*
	Non-exporting Firm (N=40)	0.509	1.353
		[0.171]	[0.276]
		0.476	*1.333*
Ethnicity of Manager	African (N=16)	0.499	1.468
		[0.137]	[0.361]
		0.478	*1.435*
	Non-African (N=31)	0.517	1.281
		[0.201]	[0.177]
		0.472	*1.271*
Size (Number of Workers)	[1,20) (N=21)	0.528	1.419
		[0.147]	[0.314]
		0.506	*1.395*
	[20,50) (N=7)	0.504	1.398
		[0.236]	[0.303]
		0.440	*1.373*
	[50, 100) (N=7)	0.457	1.313
		[0.193]	[0.202]
		0.423	*1.301*
	[100,) (N=12)	0.517	1.201
		[0.208]	[0.097]
		0.474	*1.198*
Location	Nairobi (N=26)	0.510	1.375
		[0.149]	[0.334]
		0.485	*1.345*
	Other Location (N=21)	0.513	1.308
		[0.217]	[0.146]
		0.462	*1.300*

Note: The figures in square brackets are standard deviations, and figures in italic are geometric means.