Efficiency and Productivity Change in Lao Garment Industry: A Nonparametric Approach

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I. Introduction

A production shift in the global textile and garment industry from newly industrialized economies to developing countries in Asia, in conjunction with the implementation of an open door policy, gave birth to the Lao garment industry in the early 1990s. The industry has since expanded steadily and become a major export sector. Garment exports have flourished over the decade and reached more than US$145 million in 2005, accounting for about one-third of the country's merchandise exports (Vixathep, 2008).

In addition, the Lao garment industry has played an essential role in poverty reduction. It is the major non-agricultural sector which provides employment opportunities and enables income generation for the rural poor. More than one-fourth of the labor force in manufacturing (about 27500 workers), most of which are less educated young women from rural areas, are directly employed in this industry.

Prior to the Multi-Fiber Arrangement (MFA) phase-out in 2005, there were several discussions on the uncertain future and the survival of this crucial industry. At the global level, it was predicted that China and India would benefit from the MFA termination and other small garment producers located far from major markets would lose market shares (Nordås, 2004). At the country level, it is argued that unless there are some initiatives to improve the situation, many of the Lao enterprises and some joint venture firms would not survive, several thousands of jobs would be lost, foreign exchange earnings would drop and the national economy would suffer (Boutsivongsakd et al., 2002).

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However, it turns out that the adverse impacts of the MFA phase-out have not yet been evident in the Lao garment industry (NSC, 2007a). This favorable development is accompanied by the implementation of the Safeguard policy by the European Union (EU) and the United States on China's garment exports. Yet, amid such positive development trends, the competitiveness of the Lao garment industry is still lower than many rival exporters in the region and elsewhere. Longer lead time and low labor productivity are deemed the main factors affecting the international competitiveness of the industry (NSC, 2007a; Rasiah, 2009).

Despite its crucial role, the majority of existing literature is available in form of strategic papers and reports (Thornton, 1999; Boutsyvongsakd et al., 2002; NSC, 2007a-2007d), whereas research studies on efficiency and productivity of Lao garment industry are still very limited, particularly analyses at the firm-level. Drawing from available literature, labor productivity in Lao garment industry is found to be lower than that of neighboring competitors due to lack of skilled labor, high absence rate and high labor turn-over rate (Sakurai and Ogawa, 2006). It also appears to be affected by capital intensity and labor quality (Inthakesone, 2007). Productivity growth and wage elasticity of export are still low owing to an increase in employment in low-value-added activities and low technological capacity. This would give rise to a need for technological deepening and upgrading and productivity enhancement, so as the industry could sustain its firm-level competitiveness and sufficiently root in the country (Rasiah, 2009). Furthermore, the management of garment factories in Laos shows a rational behavior in business operation, with large companies being more rational than smaller ones owing to their superiority in knowledge, technology and financial resources (Wongpit, 2006).

In view of filling this study gap, the present research study intends to assess firm efficiency with its determinants, and to evaluate productivity growth and sources of such changes. The paper addresses such questions as: What is the industry's average efficiency level? Are there any differences in efficiency and productivity among different ownership types? Do firm characteristics exert any impacts on technical efficiency? Is there any productivity growth after the MFA phase-out?

The paper begins with a brief overview of the Lao garment industry and major developments in Section 2. Section 3 reviews relevant literature and presents models for efficiency and productivity analysis. Data and variables are described in Section 4. Section 5 presents and discusses the empirical results and findings. Section 6 provides major conclusions.

II. Overview of Lao Garment Industry

II.1 Emergence and role of the garment industry

The modern history of the Lao garment industry is relatively short. In 1990 there were merely two factories operating and exporting garment products of approximately US$6 million, accounting for about 9%[1] of merchandise exports. In the following decade, however, Laos experienced remarkable emergence of this industry until the end of the quota era. The number of exporting firms increased to 58 in 1998 and fluctuated between 52 and 59 during 1999-2006. Over the same period the number of subcontractors increased steadily to 55 factories in 2005 (Table 1).

With respect to output, albeit some fluctuations the nominal export value increased nearly twofold from US$87 million in 1995 to US$151 million in 2006, but the real export value showed a more volatile trend with a peak at US$120 million in 2004. Upon the MFA phase-out, however, it declined to US$57 million in 2006. A drastic drop in real export in 2005-2006 is most likely due to an escalation of export value index by

Table 1: Basic statistics of Lao garment industry 1995-2006

Year	Export firms (subcont.)	Workers (persons)	Nominal exports (1000 US$)	Exports at 2000-prices (1000 US$)	Real growth (%)	% share in goods exports
1995	N/A	N/A	87,000	92,402	–	27.97
1996	N/A	N/A	62,000	63,442	−31.34	19.20
1997	N/A	N/A	73,056	67,218	5.95	20.35
1998	58 (10)	17,200	76,146	68,070	1.27	20.58
1999	55 (18)	18,000	100,026	106,305	56.17	32.16
2000	53 (26)	19,000	108,087	108,087	1.68	32.75
2001	52 (26)	20,000	103,486	106,984	−1.02	31.26
2002	53 (27)	21,462	103,380	113,594	6.18	34.69
2003	55 (31)	23,846	115,134	113,363	−0.20	32.07
2004	57 (43)	26,000	131,720	119,746	5.63	36.49
2005	58 (55)	27,500	144,868	86,518	−27.75	33.30
2006	59[a] (57[a])	N/A	151,182	56,616	−34.56	N/A

Source: Association of the Lao Garment Industry (ALGI), 2007.

Notes: 1. Figure in parentheses in column (1) represents number of branches and subcontractors.
2. Export value index is used for deflating nominal export value (base year=2000).
3. Superscript “ a ” denotes that the data are for January-March, 2006.
4. Data of merchandise (goods) exports are extracted from World Development Indicators, 2007, World Bank.

Table 2：Structure of enterprises in Laos

No.	Description	2002	2003	2004	2005
1	Number of enterprises	24,742	25,607	26,200	23,420
	Large size	112	119	207	144
	Medium size	604	614	722	775
	Small size	24,026	24,874	25,271	22,501
2	Production value（billion Kip）	1,423	2,314	2,911	N/A
3	Total labor in industry	91,034	98,557	103,021	101,945
4	% share of labor in garment industry	23.58	24.20	25.24	26.98

Source: Ministry of Industry and Commerce, Vientiane, Lao PDR and ALGI, 2007
Note: Enterprises with 100 employees and above are classified as large, between 10 and 99 medium, and less than 10 small.

67% and 167% compared to the base year of 2000, respectively. This trend is also reflected in the rate of real growth, which was mainly positive in the MFA-period, but has turned negative in the post-MFA period.

Along with the hydropower and mining sectors, the garment industry is among the top export sectors earning foreign exchanges for the country. Its share in merchandise exports increases from about 20% in 1996 to 33% in 2005（Table 1, column 6）. Garment exports ranked first in the export list during 1998-2002 and have just been surpassed by gold and copper exports recently（NSC, 2007a）. Furthermore, the garment industry is the largest non-agricultural sector which provides employment opportunities for the young labor force, especially rural females. It employs more than a quarter of about 100,000 labors in the industry sector and this trend has been increasing for recent years（Table 1 and 2）.

One unique feature of the Lao garment industry is the provision of accommodation and transportation. Although the wage rates are lower than that of some other LDCs, the majority of garment factories in Laos provide dormitory, transportation to and from factories, and meal free of charge. With a minimum wage of US$26/month, Lao wage rates are among the lowest compared to some main garment exporters（NSC, 2007a）.

II.2 Export and import in textile and apparel products

The Lao garment industry is highly export oriented. It exports the entire production to world's major markets, especially the EU. In 2005 the garment industry（SITC 84）recorded a trade surplus of US$164.1 million, while the textile industry（SITC 26 and 65）had a deficit of US$92.9 million. Overall, the textile and garment industry made a surplus of about US$71.2 million[2]. On the other hand, with the absence of the backward-linkage industry, 88% of fabrics and accessories for production are imported from ASEAN countries, mainly Thailand (71%) and Vietnam (15%).

According to the Association of the Lao Garment Industry (ALGI), the pattern of Lao garment exports to the major market is characterized by the Generalized System of Preferences (GSP) applied by the EU[3]. Under this scheme Lao exporters need to fulfill certain requirements of the rule of origin (ROO) in order to receive export quotas from the EU. There are two types of ROO: (1) Derogations: Laos needs to request a derogation to use raw materials from other countries with a ceiling on exports to EU, which is valid for 2 years and must be renewed upon expiration; and (2) ASEAN Cumulative Rules of Origin: As a member of ASEAN Laos can use raw materials from ASEAN members for knitted and woven products exported to EU, provided that the domestic value-added must be higher than the highest value of imported materials.

II.3 Recent development trend and challenges

Following the MFA phase-out, the Lao garment industry has entered a critical phase with fiercer competition, but its development is hindered by many factors. First, the industry has developed around the capital city, Vientiane. The resulting high concentration has partly given rise to the so-called local labor shortage. Garment workers usually go back to their home town during the farming season to help their families. Many of them do not come back or change their jobs or factories, which in turn leads to high labor turn-over rates of 30-40% per annum. Moreover, development in other industries has driven up the wage rates and drawn labor from the clothing industry. Company owners and managers find it more and more difficult to recruit and retain new workers.

Second, being a landlocked country, garment exporters in Laos have to rely on sea transport in neighboring countries. Currently, Lao exporters are using three sea ports for delivery, namely Bangkok port in Thailand, Danang port and Cua Lo port both in Vietnam. Complicated customs procedures and the associated high transportation cost lead to higher costs of doing business, lower mark-up margins, longer lead time (up to 70 days), and thereby deteriorate the industry's competitiveness. Also, being located far from the main markets, Lao garment exporters have to rely on the assistance and services of ALGI for market information and market access. On the other hand, foreign exporters are in a better position, because they can obtain updated information from parent companies and headquarters.

Third, Lao comparative advantage in low labor cost in partly compensated by low productivity level. Despite an improvement in labor productivity among garment factories in recent years, the productivity level in Laos is still very low (1,348 pieces/worker/year). In fact, it is the lowest compared to South Asian competitors and China (7,500 pieces/worker/year). Shortage of skilled labor, low education level of workers, high labor turn-over rate, and low capital productivity have been figured out as main factors affecting labor productivity (NSC, 2007a).

Fourth, our field surveys have revealed that many factory owners and managers are quite pessimistic about the industry's performance in the post-MFA era and upon the termination of the Safeguards on China's exports, as export revenue has declined after 2004 and the competition has intensified. Also, the normal trade relation with the U.S. accorded in December 2004 using MFN treatment has not yielded expected positive effects to Lao garment exports (NSC, 2007a).

Overall, the competitiveness of the Lao garment industry is impeded by several factors, such as inefficiency in ports and transportation; weak physical infrastructure; lack of backward linkage or supporting industries; lack of access to market information and finance, low labor productivity and the like. In response to these challenges, ALGI has adopted an approach to avoid direct competition with China and to learn from China on how to export to US. Moreover, the association has advised its members to: (1) select a main market for exports, preferably the EU market; (2) continue producing low-price items to compensate for high transit costs; and (3) focus on EU, New Zealand, Norway, Japan and Canada markets. To date, Lao garment exports cover merely 0.3% of EU's imports from LDCs, but the country has a ceiling of 3% and hence there is still much room to improve (based on an interview with the president of ALGI). The key issue for longer-term development is how to enhance efficiency and productivity in order to cope with more intensified competition, improve competitiveness and further develop this industry.

III. Measurement of Efficiency and Productivity Growth

III.1 Brief review of literature

Following the work of Solow (1957), the time continuous analysis applies derivatives of production, cost or profit functions to estimating productivity growth and technical progress. On the other hand, the time discrete analysis uses index numbers for discrete data points in measuring productivity level and growth, particularly upon the introduction of input distance functions by Shephard and Malmquist in the early 1950s (Lovell, 2003).

In an effort to avoid approximating continuous time concepts, Caves et al. (1982) introduced the input based Malmquist productivity index (MI) as the ratio of two input distance functions. This index can overcome the problem of time differences and can be used for comparing a firm at two different time periods or two firms at one point or different points in time under very general conditions of production structures.

Another influential development is the concept of efficiency measurement introduced by Farrell (1957), who proposed a decomposition of economic efficiency of a firm into allocative efficiency and technical efficiency. Farrell's technical efficiency is the reciprocal of the input distance function and the main element of the Malmquist productivity index.

In combining Farrell's concept of efficiency measurement with the idea of productivity measurement introduced in Caves et al. (1982), Färe et al. (1992) proposed a decomposition of the MI into two components, one capturing the efficiency change (*catch-up*) and the other one measuring the technical change (*frontier-shift*). This decomposition, which uses the constant returns to scale (CRS) technology as the reference technology, was extended in Färe et al. (1994) to conceptualize a technology characterized by variable returns to scale (VRS). Specifically, the efficiency change component calculated under CRS was further factored into pure technical efficiency change and scale efficiency change, which are calculated related to VRS. It is also argued that the technical change computed under CRS technology would capture the maximum average product and be consistent with the concept of technical change defined by Solow (1957), and that the CRS technology would be appropriate for calculating Malmquist productivity as a measure of total factor productivity (TFP) (Färe et al., 1997).

The construction of a grand frontier from observed data points and calculation of distance functions often use the non-parametric approach, the data envelopment analysis (DEA), which was formally introduced by Charnes, Cooper and Rhodes (1978). The Malmquist index, which has distance functions as key building blocks, is often calculated in this way. In this paper, DEA models and the Malmquist TFP index are applied on the firm-level data of the Lao garment industry for 2004-2005. To our knowledge, this attempt is the first in micro-level analysis of efficiency and productivity growth for this crucial industry in Lao economy.

III.2 Data envelopment analysis and determinants of efficiency

a. The Output-oriented CRS Model

In DEA, efficiency is defined as the ratio of output to input. DEA uses the distance functions and the linear programming to maximize this ratio. The CRS model operates on the assumption of constant returns to scale. The input-oriented model aims at reducing inputs to the minimum level, while holding outputs unchanged. The output-oriented model attempts to increase outputs to the maximum potential level, while keeping inputs at the observed level. Under the CRS technology, the two types of models yield the same technical efficiency score.

It is often difficult for garment firms to increase inputs of production, particularly capital and labor. Hence, they would make necessary efforts to expand the output using the existing inputs. Therefore, the output-orientation models are opted for empirical analysis.

The output-oriented CRS model is written in envelopment form as follows:

$$\max_{\eta,\boldsymbol{\mu}} \quad \eta, \tag{1}$$

$$\text{Subject to} \quad -\mathbf{x}_i+\mathbf{X}\boldsymbol{\mu}\leq\mathbf{0}, \qquad (i=1,2,\cdots,n)$$

$$\eta\mathbf{y}_i-\mathbf{Y}\boldsymbol{\mu}\leq\mathbf{0},$$

$$\boldsymbol{\mu}\geq\mathbf{0}$$

where ($\mathbf{X}$, $\mathbf{Y}$) denotes a matrix of inputs and outputs, $\mathbf{x}_i$ and $\mathbf{y}_i$ denote the vector of inputs and outputs, η is a real variable, and $\boldsymbol{\mu}$ denotes a transpose of a non-negative vector $\boldsymbol{\mu}=(\mu_1,\cdots,\mu_n)^T$ of variables.

The solution of this model satisfies that $1\leq\eta<\infty$. Hence, the measure defined as

$\theta = 1/\eta$, which varies between zero and one, is called the output-oriented *technical efficiency score* (TE score). A decision making unit (DMU) with a TE score of unity ($\eta^* = 1$) and zero slacks (no input excess and output shortfall) is identified as technically efficient (Farrell-efficient).

b. The Output-oriented VRS Model

The VRS model introduced by Banker et al. (1984) allows for variable returns to scale (VRS). The output-oriented VRS model evaluates the efficiency of DMU_i ($i=1,2,\cdots,n$) by solving the following linear program in envelopment form:

$$\begin{aligned} &\max_{\phi,\boldsymbol{\lambda}} \quad \phi, && (2)\\ &\text{Subject to} \quad -\mathbf{x}_i + \mathbf{X}\boldsymbol{\lambda} \leq \mathbf{0}, \quad (i=1,2,\cdots,n)\\ &\qquad\qquad \phi\mathbf{y}_i - \mathbf{Y}\boldsymbol{\lambda} \leq \mathbf{0},\\ &\qquad\qquad \boldsymbol{e}\boldsymbol{\lambda} = 1\\ &\qquad\qquad \boldsymbol{\lambda} \geq \mathbf{0} \end{aligned}$$

where the measure ϕ is a real variable, $\boldsymbol{\lambda}$ is a non-negative vector $\boldsymbol{\lambda} = (\lambda_1, \cdots, \lambda_n)^T$ and other variables are defined as above. The difference between the two models lies in the constraint $\boldsymbol{e}\boldsymbol{\lambda} = 1$.

Similarly, any DMU with pure technical efficiency score of unity ($\phi^* = 1$) and zero slacks is considered purely technically efficient. The efficiency index obtained from the VRS model ($1/\phi$) is called *pure technical efficiency score* (PTE score).

c. Decomposition of technical efficiency and scale efficiency

Generally, the efficiency performance of a DMU might be influenced by its inefficient operation or by certain disadvantageous conditions, such as its operation scale. If a DMU is fully efficient in both TE and PTE ($TE=1$, $PTE=1$), it is said to operate at the *most productive scale size*. If a DMU achieves full PTE but has a lower TE ($PTE=1$, $TE<1$) it is said to operate locally efficiently but not globally efficiently due to its scale size. Derived from the relationship between the two models, technical efficiency can be decomposed into pure technical efficiency and scale efficiency (SE):

$$TE = PTE \times SE \text{ or } SE = TE/PTE \quad (3)$$

d. Determinants of technical efficiency

Following Coelli et al. (2005), the efficiency index is assumed to be a function of certain explanatory variables in additive form. To this end, the TE score from the CRS model is employed as dependent variable in a regression model to assess certain possible determinants of technical efficiency:

$$TE_i = \delta_0 + \sum_j \delta_j z_{ij} + \varepsilon_i, \quad (j=1,2,\cdots,q) \tag{4}$$

Given the dataset, the above equation can be specified as:

$$TE_i = \delta_0 + \delta_1 age_i + \delta_2 \ln capin_i + \delta_3 pstaff_i + \delta_4 foe_i + \delta_5 jv_i + \varepsilon_i \tag{5}$$

where δ_0 is the constant, ε is the error term and the index i denotes the *i-th* firm. The coefficients δ_j $(j=1,2,\cdots,5)$ are to be estimated. The definition of independent variables (z_{ij}) is presented in Section IV.2.

III.3 The Malmquist productivity index

In the second part, an output-oriented Malmquist productivity index is used to evaluate total factor productivity growth of garment firms. In other words, this index measures the TFP changes of individual DMUs between two different time periods and represents the sources of such changes.

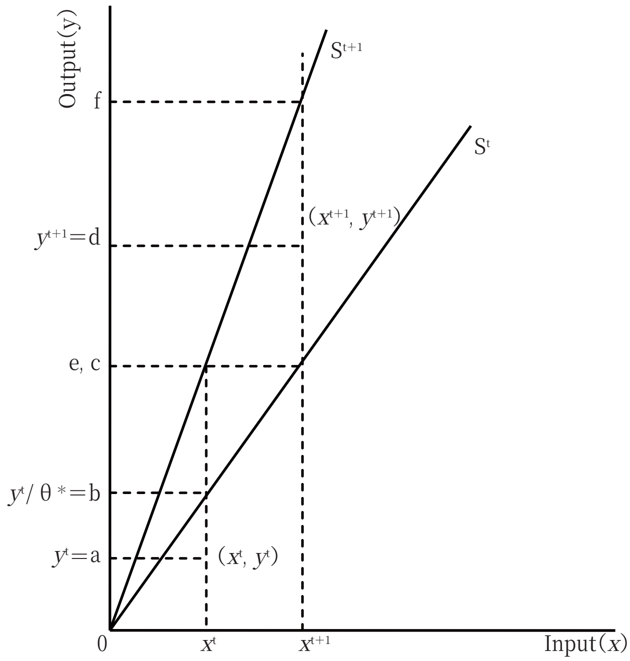
For time period $t=1, 2,\cdots$ the production technology $S^t=\{(x^t, y^t): x^t \textit{ can produce } y^t\}$ models the transformation of inputs into outputs.

The output distance function can be defined at time t as:

$$D^t(x^t, y^t)=\inf\{\theta : (x^t, y^t/\theta)\in S^t\}=(\sup\{\theta : (x^t, \theta y^t)\in S^t\})^{-1} \tag{6}$$

It measures how far an observation is from the grand frontier of technology and equals the reciprocal of Farrell's efficiency. In Figure 1: $D^t(x^t, y^t)=0a/0b$. By definition the distance function is homogenous of degree +1 in output.

At this point, it is worth noting that for simplicity of the presentation the necessary characteristics, such as weakly disposable outputs and distance function of less than unity on the technology S^t are assumed inclusively. Readers could refer to Färe et al. (2001) for details of the assumptions and derivation.



Source: Adapted from Färe et al. (1994, p.70)

Figure 1: Malmquist index and distance functions

Next, the Malmquist productivity index defined in Caves et al. (1982) can be written for period *t* and *t+1* as follow:

$$MI^t_{CCD} = \frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \text{ (reference technology of period } t) \quad (7)$$

$$MI^{t+1}_{CCD} = \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \text{ (reference technology of period } t+1) \quad (8)$$

where the subscript CCD stands for Caves, Christensen, and Diewert.

The output-based Malmquist productivity index is defined as the geometric mean of two CCD-type Malmquist indices of two periods (the MI is said to hold for VRS technology as well):

$$MI^t(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^t(x^{t+1}, y^{t+1}/CRS)}{D^t(x^t, y^t/CRS)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1}/CRS)}{D^{t+1}(x^t, y^t/CRS)}\right]^{1/2} \quad (9)$$

Following Färe et al. (1992), by allowing for inefficiencies, the index can be decomposed into efficiency change (*EFFCH*) and technical change (*TECH*), i.e. *MI=EFFCH*TECH*

$$MI^t(x^{t+1}, y^{t+1}, x^t, y^t)=\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}\times\left[\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})}\times\frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)}\right]^{1/2} \qquad (10)$$

where

$$EFFCH=\frac{D^{t+1}(x^{t+1}, y^{t+1}/CRS)}{D^t(x^t, y^t/CRS)} \qquad (11)$$

$$TECH=\left[\frac{D^t(x^{t+1}, y^{t+1}/CRS)}{D^{t+1}(x^{t+1}, y^t/CRS)}\times\frac{D^t(x^t, y^t/CRS)}{D^{t+1}(x^t, y^t/CRS)}\right]^{1/2} \qquad (12)$$

EFFCH captures the change in efficiency and measures how much closer a DMU moves to the frontier (catch-up effect), while *TECH* captures the change in frontier technology and measures how much the frontier shifts at each observation's input mix (frontier-shift effect).

In the extended decomposition proposed by Färe et al. (1994), the efficiency change term (*EFFCH*) can be expressed as the product of (i) the pure efficiency change component in VRS technology (*PEFFCH*) and (ii) the scale efficiency component (*SCALECH*) to capture the deviation between the CRS and VRS frontiers. That means *EFFCH= PEFFCH*SCALECH* and *MI=TECH *PEFFCH*SCALECH:*

$$PEFFCH=\frac{D^{t+1}(x^{t+1}, y^{t+1}/VRS)}{D^t(x^t, y^t/VRS)} \qquad (13)$$

$$SCALECH=\frac{D^t(x^t, y^t/VRS)/D^t(x^t, y^t/CRS)}{D^{t+1}(x^{t+1}, y^{t+1}/VRS)/D^{t+1}(x^{t+1}, y^{t+1}/CRS)} \qquad (14)$$

Observing Figure 1, the Malmquist index can be expressed as:

$$MI^t(x^{t+1}, y^{t+1}, x^t, y^t)=\left(\frac{0d/0f}{0a/0b}\right)\left[\left(\frac{0d/0e}{0d/0f}\right)\left(\frac{0a/0b}{0a/0c}\right)\right]^{1/2}$$

$$=\left(\frac{0d}{0f}\right)\left(\frac{0b}{0a}\right)\left[\left(\frac{0f}{0e}\right)\left(\frac{0c}{0b}\right)\right]^{1/2} \qquad (15)$$

The Malmquist index, as expressed in equation (9) or (10), of greater than unity implies positive TFP growth. Similarly, efficiency improvement and technical advancement occur, if EFFCH and TECH are greater than unity. Otherwise, deterioration in productivity, efficiency and frontier technology is evident, if the three corresponding indices are smaller than unity. The interpretation for PEFFCH and SCALECH follow the same pattern.

IV. Data and Variables

IV.1 Data

Statistical data for the empirical analysis are obtained from the Ministry of Industry and Commerce. In addition, information from two field surveys conducted by the author in February and December 2006 has proved useful for understanding the issues concerned and interpreting the results. The initial dataset contains 38 garment firms for 2004-2005 and covers the transition period from quota to post-quota era. Upon data mining, the final dataset consists of 33 observations and covers 57-58% of garment firms listed as members of the ALGI for the years under study (Table 3).

The Lao garment industry is dominated by foreign-owned enterprises (FOEs) (52%) and joint venture (JV) firms (21%), while local enterprises make up only about 27% in terms of number. Moreover, FOEs and JV firms are leading in employment and exports, as they employ more than 80% of the industry's labor force and contribute 70-73% of the garment exports. With respect to firm size, only one firm

Table 3 : Composition of data on Lao garment industry

		Firm		Labor		Export	
		Number	Share (%)	Persons	Share (%)	Value (1000 U$)	Share (%)
2004	Lao	9	27.27	2,591	19.56	56,190	30.38
	FOE	17	51.52	7,921	59.81	100,036	54.08
	JV	7	21.21	2,732	20.63	28,743	15.54
	Total	*33*	*100.0*	*13,244*	*100.0*	*184,970*	*100.0*
2005	Lao	9	27.27	2,719	18.74	31,438	26.86
	FOE	17	51.52	8,500	58.58	61,608	52.65
	JV	7	21.21	3,291	22.68	23,976	20.49
	Total	*33*	*100.0*	*41,593*	*100.0*	*117,022*	*100.0*

Source: Author's calculations. Data are from the Ministry of Industry and Commerce of Laos.
Notes: 1. ' Lao ' denotes Lao firm.
2. ' FOE ' represents foreign-owned enterprise.
3. ' JV ' represents joint venture firm.

(3%) is medium-sized enterprise and the remaining 32 firms (97%) are classified as large-sized enterprises. In terms of business structure, roughly 40% are operating on the FOB basis and most of them are foreign and JV firms (NSC, 2007a).

IV.2 Variables

The DEA models and the Malmquist TFP index are estimated with two inputs (capital, labor) and one output (exports). For a more precise result, the calculation of firm efficiency should apply the combination of capital, labor, materials and output. The use of two inputs in this analysis is solely due to lack of information on materials. Furthermore, the estimation of the Malmquist index requires panel data, and hence, the monetary variables (exports, capital) are expressed in real term. The variables for the analysis are defined as follows:

- '*Output (Exports)*' represents real exports of the enterprises in 2004 and 2005 denominated in US dollar. The export value index is used as deflator (base year= 2000);
- '*Input 1 (Capital)*' is the US dollar value of the fixed assets used as a proxy for capital. Since most of the firm's fixed assets are imported capital goods (machinery, trucks and vehicles, construction materials etc.), we use the import value index as deflator (base year= 2000). Also, the consumer price index with the same base year is used for comparison purposes;
- '*Input 2 (Labor)*' is the total number of workers (labor) as of the end of 2004 and 2005;
- '*age*' denotes the number of years of operation and is defined as the difference between year 2004 or 2005 and the establishment year;
- '*lncapin*' is the capital intensity in natural logarithm (in US dollar/worker) and defined as the ratio of fixed assets over the total number of employees (this variable is deemed to give some measure of the technical level of garment firms);
- '*pstaff*' represents the percentage share of staff to workers (staff includes managers, head of production lines, technicians and secretaries). This variable is considered as a measure of quality of labor; and

- ‘*lao*’, ‘*foe*’, and ‘*jv*’ are dummy variables, which denote Lao firms, wholly foreign-owned enterprises and joint venture firms, respectively (*lao* is reference group). The ownership is predetermined in the dataset.

The empirical analysis faces some limitations due to lack of information on capital flow and working hours or wages. First, owing to data limitation ‘fixed assets’ are used as proxy for capital instead of capital flow. This might understate the capital input of some local firms, because they tend to use second-hand equipment due to their limited financial capacity. The use of capital services would better capture the replacement cost of this relatively cheaper second-hand equipment. Consequently, the TE score of some local firms might be somewhat upward-biased. Second, the use of number of workers as a proxy for labor does not capture over-time work and longer working hours in smaller firms during the peak season.

The summary statistics of the dataset are presented in Table 4. On average, exports of a garment firm in Laos decreased from US$5.6 million in 2004 to US$3.5 million in 2005. The average capital stock per worker expanded slightly from US$1.1 million to US$1.3 million and the average number of workers per factory increased from 401 to 440 over the same period. The average age of garment firms in Laos is about 10 years old. The average capital intensity and share of staff to workers remain relatively stable over the study period.

Table 4 : Summary of main variables

Lao garment 2004	Obs.	Mean	Std. Dev.	Min	Max
Exports (US$ thousand)	33	5,605	4,694	511	20,903
Capital (US$ thousand)	33	1,085	1,376	63	5,899
Labor (persons)	33	401	296	86	1,261
Firm age (years)	33	10	3	2	14
Capital intensity (US$/worker)	33	3,323	4,368	91	19,331
Share of staff (%)	33	6.88	7.39	0.31	42.19
Lao garment 2005	Obs.	Mean	Std. Dev.	Min	Max
Exports (US$ thousand)	33	3,546	2,974	139	14,614
Capital (US$ thousand)	33	1,260	1,451	27	6,433
Labor (persons)	33	440	341	68	1,520
Firm age (years)	33	11	3	3	15
Capital intensity (US$/worker)	33	3,341	3,700	228	16,916
Share of staff (%)	33	5.15	3.38	0.31	15.17

Source: Author's calculations.
Note: Monetary variables (exports, capital, and capital intensity) are denominated in real term at 2000-prices.

V. Empirical Results

V.1 Efficiency performance

a. Trend of efficiency scores

Over the period under study, the average TE level of the Lao garment industry is about 30% and the average PTE level is roughly 43% (Table 5). However, a more detailed examination of efficiency trends reveals that the average TE score decreased from 0.33 to 0.29 and the average PTE score decreased from 0.45 to 0.41. Although the decrease is rather marginal, this result implies that the gap between the best performers and the remaining garment firms has become wider. This might result from the MFA phase-out, which has induced more competition at both global and national levels. For Laos, many firms have faced a drastic decrease in orders and loss of orders. These include some of the best performers of 2004 and would lead to a wider gap among garment firms.

A comparison of individual firms during 2004-2005 reveals that 18 firms experienced efficiency deterioration, of which three firms were best performers and 13 others recorded a TE score of 0.18 or above in 2004. On the other hand, out of 14 factories achieving TE augmentation, ten recorded a TE score of less than 0.17. Only one firm was able to retain the " most efficient " status. These trends imply that most of relatively efficient garment factories have experienced deterioration in efficiency over the study period which could lead to a fall in average TE score and wider gap in efficiency performance.

In terms of scale efficiency, garment firms in Laos appear to perform relatively better than the previous two cases. In other words, they tend to have chosen a more appropriate production scale, as the SE scores of the firms under study vary between 0.7 and 0.8 and the average SE score remains practically unchanged at 0.74. The overall trend of scale efficiency, however, is similar to that of TE and PTE.

b. Comparison of efficiency among types of ownership

Table 5 also summarizes the three efficiency indices by ownership. Overall, it appears that Lao enterprises have achieved an efficiency level above the industry's average for the whole period under study. On the other hand, foreign-owned firms seem to perform more efficiently than joint venture firms in 2004, but the trend is

Table 5 : Efficiency indices classified by ownership

2004		mean and standard deviation					
	Number	**TE index**		**PTE index**		**SE index**	
Ownership	(% share)	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
LAO	9 (27.27)	0.396	0.305	0.554	0.333	0.779	0.286
FOE	17 (51.52)	0.321	0.337	0.434	0.344	0.714	0.247
JV	7 (21.21)	0.262	0.170	0.364	0.224	0.716	0.137
Total	*33 (100.0)*	*0.329*	*0.296*	*0.452*	*0.318*	*0.732*	*0.235*
2005		Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
LAO	9 (27.27)	0.334	0.265	0.474	0.325	0.792	0.277
FOE	17 (51.52)	0.227	0.236	0.356	0.287	0.696	0.277
JV	7 (21.21)	0.385	0.334	0.460	0.379	0.819	0.121
Total	*33 (100.0)*	*0.290*	*0.267*	*0.411*	*0.313*	*0.748*	*0.252*

Source: Author's calculations.
Notes: 1. See notes in Table 3 for abbreviation of ownership.
2. Statistical differences in the average efficiency measures among the three ownership forms are tested by means of ANOVA.
3. ANOVA reveals no statistically significant differences among the types of ownership at the 10% level or higher.

reversed for 2005.

These results are rather surprised, because FOEs and JV firms are considered to have superior technologies, managerial skills, marketing, and better access to markets and finance and hence higher efficiency. However, as explained in the previous section, the result might be biased toward local firms owing to the use of capital stock (fixed assets) and number of workers as input variables for DEA, which could undermine the longer operation life of the probably newer equipment in FOEs and JV firms. Moreover, the average efficiency score can be influenced by such factors as the number of inputs and the decrease or loss of orders.

In addition, as indicated by the Analysis of Variance (ANOVA), the differences among the types of ownership are statistically insignificant implying that the efficiency level of garment firms in Laos is comparable regardless of ownership. These results should be interpreted with caution, because the ANOVA is relatively sensitive to the distribution of the efficiency indices due to unequal sample sizes. Hence, these findings should be viewed in close relation with those of the regression and productivity analysis.

c. Determinants of technical efficiency

Equation (5) is estimated by the ordinary least square (OLS) and the Tobit model. The results from the two methods are very similar in terms of sign and significance of the determinants (Table 6). All regressions have been tested and corrected for heteroskedasticity. Most surprisingly, the coefficient estimates are statistically significant for only one variable: staff share (*pstaff*).

Ownership: The efficiency differences among the three types of ownership are insignificant, although the signs and magnitudes differ in some cases. This result lends support to the above argument that efficiency among garment firms in Laos is comparable regardless of ownership. Such a result is attributable to following factors. First, the weakness in the system, such as inappropriate infrastructure; bottlenecks in transportation due to absence of sea access and port; backwardness in information and communication technology; etc., might prevent enterprises from realizing their potential (see NSC (2007a) for further discussion). Second, the reason for such results might lie in the erroneous collection and record of data.

Firm age: The insignificance of coefficient estimates of age points to two important issues. First, *ceteris paribus*, average young firms would be able to catch up with other competitors in terms of managerial, technical and marketing skills to improve firm efficiency in relatively short time. This could be explained by the intra-industry specialization of the Lao garment industry in relatively simple product lines (Vixathep and Matsunaga, 2007; Vixathep, 2008) and the dominance of CMT-business, which would enable such a catch-up in a short period of time. Second, the years of operation among garment firms in Laos are comparable which would lead to comparable technical and skill levels (Table 1). Specifically, about 82% of the observed garment firms have been in operation for 10-15 years. This implies that they would be comparable in many aspects of production, marketing and exports.

Technological level: The coefficient for capital intensity is negative and insignificant meaning that an increase in capital investment alone would not yield higher firm efficiency. This result might have multiple implications. First, by definition technical efficiency is negatively related to capital-labor ratio. A massive investment in equipment, which is not extensively used for production, would lead to a larger capital-labor ratio and lower efficiency. The recent declining trend in orders faced by many garment firms in Laos might have some impact on this result. Second, the current technology level might not be appropriate for the skill level of workers. Vu (2005) found a similar result for Vietnam and suggested that the investment was not

Table 6：Determinants of technical efficiency（2004, 2005）

	Dependent variable: Technical Efficiency Score			
	OLS		Tobit model	
Variable	2004	2005	2004	2005
constant	0.311	0.434	0.274	0.450
	(0.413)	(0.410)	(0.422)	(0.385)
age	0.010	−0.001	0.012	−0.001
	(0.015)	(0.019)	(0.014)	(0.017)
lncapin	−0.028	−0.021	−0.033	−0.023
	(0.052)	(0.046)	(0.053)	(0.043)
pstaff	0.019***	0.010	0.029***	0.010
	(0.005)	(0.015)	(0.011)	(0.013)
foe	0.025	−0.093	0.037	−0.088
	(0.118)	(0.119)	(0.119)	(0.110)
jv	−0.047	0.069	−0.063	0.069
	(0.099)	(0.145)	(0.098)	(0.132)
Observations	33	33	33	33
Adjusted R^2	0.278	0.091	—	—
Log likelihood	—	—	−8.068	−3.679
Pseudo-R^2	—	—	0.445	0.278

Source: Authors ’ calculations.
Notes: 1. The explanatory variables stand for: *age*= firm age; ln*capin*= capital intensity in natural logarithm; *pstaff*= percentage share of staff to workers; *foe*= foreign-owned enterprise; and *jv*= joint venture firm.
2. The regressions are corrected for heteroskedasticity and corrected standard errors are in parenthesis.
3. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

comprehensive or the human resource was not adequate. Our field surveys also reveal a decrease in garment orders and a need for skill training raised by garment firm operators（managers and owners）in Vientiane. Also, the problems of low skill base of labor and the need for improving education system have been figured out as causes of low productivity in NSC（2007a）.

Staff share: The estimate of staff share on efficiency is the only significant coefficient and implies that, if this factor is controlled for, one percentage point increase would be associated with efficiency augmentation by 0.02% point. The effect appears to be merely marginal, but this result would imply that garment firms in Laos are facing a shortage of management staff, technical staff and line managers in enhancing efficiency. This would also lend support to the above argument that capital goods investment should match with human resource development if technical efficiency is to be improved. However, this variable is rather vague to advocate a firm conclusion. Further analysis that uses more accurate proxy for labor quality or human capital would undoubtedly yield improved results and could ascertain the argument put forward here.

V.2 Total factor productivity

a. Components of total factor productivity

The Malmquist TFP index is calculated together with the technical change, efficiency change, pure technical change and scale efficiency change for all DMUs for 2004-2005 (Table 7). A value of the MI or any of its components of greater than unity implies progress or improvement, whereas a value of less than unity denotes regress or deterioration in the corresponding components during 2004-2005. More precisely, the average annual change (increase/decrease) in the individual components can be calculated by subtracting one from the corresponding figures presented in the table.

Overall, total factor productivity of garment in Laos enterprises regressed by −40.6% (0.594-1.000) in 2005 as compared to 2004. This decrease is mainly caused by deterioration in technical progress (TECH), which records a decrease of −39.3% as compared to a fall in efficiency change (EFFCH) by merely −1.6%. The small regress in EFFCH is attributable to improvement in scale efficiency (SCALECH) of 2.4%, because there was pure efficiency worsening (PEFFCH) by −4.5% based on the VRS technology.

Table 8 presents the TFP performance of garment firms by ownership. Part D gives a more detailed picture of TFP growth, namely only 3 firms (9%) have achieved TFP enhancement and 15 firms (45%) have realized efficiency augmentation over the study period. Moreover, 12 firms (36%) and 24 firms (73%) have, respectively, achieved a progress in PEEFCH and SCALEFF in VRS technology,

Table 7 : Components of TFP with scale effect (average annual change)

	MI	TECH	EFFCH	PEFFCH	SCALECH
Average	0.594	0.607	0.984	0.955	1.024
Std. Dev.	0.278	0.049	0.465	0.393	0.187
Max	1.220	0.682	1.918	1.891	1.304
Min	0.200	0.492	0.307	0.294	0.307
Average by ownership					
	MI	**TECH**	**EFFCH**	**PEFFCH**	**SCALECH**
Lao	0.551	0.629	0.888	0.852	1.031
FOE	0.536	0.607	0.874	0.891	0.980
Joint Venture	0.791	0.579	1.377	1.242	1.123

Source: Author's calculations.
Notes: 1. MI represents Malmquist index.
2. EFFCH denotes CRS efficiency change or catch-up.
3. TECH represents CRS technical change or frontier shift.
4. PEFFCH denotes variable returns to scale efficiency change.
5. SCALECH is scale efficiency change.

Table 8 : TFP performance by ownership

Ownership	Category	MI	TECH	EFFCH	PEFFCH	SCALECH
A Lao	X > 1	0	0	3	2	7
(9 firms)	X = 1	0	0	0	1	0
	X < 1	9	9	6	6	2
B FOE	X > 1	1	0	7	5	10
(17 firms)	X = 1	0	0	0	1	0
	X < 1	16	17	10	11	7
C Joint	X > 1	2	0	5	5	7
Venture	X = 1	0	0	0	0	0
(7 firms)	X < 1	5	7	2	2	0
D Total	X > 1	3	0	15	12	24
(33 firms)	X = 1	0	0	0	2	0
	X < 1	30	33	18	19	9

Source: Author's calculations.
Notes. 1. Figures appearing in the table represent the number of garment firms in corresponding category.
2. MI represents Malmquist index.
3. EFFCH denotes CRS efficiency change or catch-up.
4. TECH represents CRS technical change or frontier shift.
5. PEFFCH denotes variable returns to scale efficiency change.
6. SCALECH is scale efficiency change.

which was a source for a lower degree of regress in EFFCH under CRS. With respect to technical progress, all the firms have recorded a regress in technical change.

The results in this analysis are consistent with the findings in previous studies for developing and transition economies that efficiency improvement occurs but technical progress is usually a rare case (see Chandran and Pandiyan (2007) for Malaysia; Nguyen and Giang (2005) for Vietnam; and Pilyavski and Staat (2008) for Ukraine). For more developed economies, growth in TFP often comes from technical progress (see Färe et al. (2001) for apparel and textile industry in Taiwan).

b. TFP performance by ownership

The bottom part of Table 7 shows the average performance in Malmquist index and its components by three ownership types: Lao, FOE and JV firms. Results from ANOVA reveal that the differences in these components are largely significant for joint venture firms, whereas the figures for Lao firms and FOEs are statistically not different. It is apparent that firms of all three ownerships recorded deterioration in TFP (between −20.9% and −46.4%) and technical efficiency (between −37.1% and −42.1%). With regard to EFFCH, joint venture firms achieved an improvement of 37.7% and this progress came from pure efficiency augmentation (24.2%) and scale efficiency change (12.3%) under VRS technology. On the other hand, Lao and foreign firms faced deterioration, but the degree of the regress in EFFCH is less than that of TFP and TECH. Also in this case the source of mitigation came from SCALECH in VRS technology.

Part A, B and C in Table 8 illustrate this trend more clearly. Specifically, three out of nine Lao firms (3/9), seven out of 17 FOEs (7/17), and five out of seven JV firms (5/7) achieved positive efficiency change. The result in the table also confirms that the source of such change came from PEFFCH and SCALECH under the VRS technology.

In interpreting the results, some points should be noted here for consideration: (i) the analysis is based on data of two adjacent years, which cover the termination of the quota system. Hence, long-term impacts of the MFA phase-out might not be evident as the statistics would contain exports and imports that have been agreed upon prior to the event; and (ii) the regress in TFP might be caused by a decrease in orders placed to garment factories in Laos and a fall in observed unit price[4] resulting from the MFA termination. In such a case, the rate of idle capital would increase, and hence, TFP is found to be deteriorated. However, efficiency and productivity might be underestimated and the garment firms would even have excess capacity. Moreover, the result of the TFP analysis might partly suffer from the lack of information of capital flows, working hours, wages and intermediate inputs as in the afore-mentioned efficiency analysis. Therefore, further research applying longer time series data of higher quality should be conducted in future to fully analyze the situation and capture the effect of MFA abolition.

VI. Concluding Remarks

Despite being small in size, the crucial role of the Lao garment industry in economic development has been evident since the last decade. In particular, the industry has contributed to foreign exchange earnings and job creation for the poor and thereby supporting the poverty reduction policy of the government. More than ever, the industry is in need for improving efficiency and productivity aiming at retaining its competitiveness and coping with labor shortage and fiercer competition from other much larger rivals in the post-MFA era and after the termination of the Safeguards on China's garment export imposed by the EU and U.S.

In recognizing these issues, the present research study evaluates firm efficiency and its determinants, and the changes in total factor productivity and the sources of such changes for garment firms in Vientiane capital. To this end, the data envelopment analysis is applied to firm-level data of 2004-2005 to calculate firm efficiency and the Malmquist TFP index with its components. The study also applies econometric techniques in evaluating impacts of determinants of technical efficiency.

The study reveals that the Lao garment industry has struggled to catch up with neighboring competitors in the post-MFA era. In terms of efficiency performance, garment firms in Laos are relatively widespread and this efficiency gap has widened over the study period, partly due to the MFA abolishment and the increasing competition in the global garment industry. Efficiency improvement and productivity augmentation are evident only at the firm level, while the opposite is observed at the industry level. There is an urgent need to enhance firm efficiency and productivity; in particular, there is much room for technical progress. Furthermore, the role of human capital is somewhat evident, in which investment in physical capital should take into the account labor skill level in order to optimally utilize new technologies. Many bottlenecks and impediments in business should be gradually removed so that garment firms in Laos, especially foreign-owned firms with greater potentials, could realize their capacity and improve their business operations.

The findings have some policy implications. First, the formulation of industrial, trade and education policies should go hand-in-hand, in order to obtain monetary and technical benefits from trade development and industrialization. Second, human resource development efforts should also be made at the grass-roots level for the poor to gain necessary basic skills to be able to contribute to and benefit from the ongoing industrialization and for the country to move faster in this process. Finally, appropriate foreign direct investment should be stimulated to attract more efficient foreign invested enterprises so as to promote efficiency and productivity enhancement in the Lao garment industry.

Notes

1 The figure is calculated by the author based on the commodity trade data from UN Comtrade (Vixathep, 2008).

2 Commodity trade data are extracted from the Comtrade database of the United Nations.

3 Much of information about GSP and recent development trends in Lao garment industry presented in this chapter is drawn from 2 field surveys conducted by the author in February and December, 2006. Further explanations on GSP are also available in NSC(2007a), p. 27.

4 The field surveys reveal that unit price and the resulting markup margins of garment suppliers have decreased.

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