Technical and Scale Efficiency of Chinese Apparel Firms

Baolu Wang and Theodoros Skevas
University of Missouri, USA

Keywords: Technical Efficiency, Scale Efficiency, DEA, Chinese Textile and Apparel

The textile and apparel (T&A) industry is facing great challenges due to its highly competitive nature. Chinese T&A industry, as one of the most important players in the world, is also facing with the severe situation because of the continually increasing of resources, labor costs, and international competition (Pfohl & Shen, 2008). Bhandari and Ray (2012) claimed that T&A firms should rationalize the inputs usage rather than pining the hope on expanding market share when placing in a highly competitive market, however, Ye and Zhou's (2013) stated that defective management ability leaded to weak resource control in Chinese T&A firms. Thus, efficiently using resource would be an inevitable challenge to all the Chinese T&A firms, and the prior research question would be how well current Chinese T&A firms using resource in their business activities.

To answer the research question, the technical efficiency (TE) and scale efficiency (SE) were employed from economics literatures. TE refers to how well a firm uses inputs to produce outputs (Rangan et., 1988). It represents the closeness of the actual production and business activities of one company and its frontier (which companies with the best technology and management level), reflecting the managerial performance to organize the inputs in the production process (Rangan et., 1988). Factors, such as unreasonable utilization of resources and low level of technology, could cause the inefficiency of TE (Ye & Zhou, 2013). SE refers to how well a firm is operating at its optimal size, representing the ability of choosing the optimum size of resources (i.e., to decide firm's size) that will attain the expected production level (Rangan et., 1988). Factors, such as number of employees and firm asset, could influence the efficiency of SE (Ye & Zhou, 2013).

The TE and SE of the Chinese T&A firms was calculated by Data Envelopment Analysis (DEA), which is a very potent technique for measuring the relative efficiency of a set of similar units (Bhandari & Ray, 2012). DEA allows finding out the reference set which can act as benchmarks instead of finding one most efficient reference, and it is capable of handling multiple inputs and outputs. As suggested by previous research (Bhandari & Ray, 2012; Ye & Zhou, 2013), labor cost, sale cost, research and development (RD) cost, number of stores, and fixed asset of Chinese T&A firms were selected as the input indexes, and revenue was selected as the output index in this study. An input-oriented model of DEA, aiming at minimizing inputs while maintaining outputs constant, was conducted due to the research concern. Variable returns to scale (VRS), meaning the return would be various along with the change of production scale, was also considered in this study due to the diverse of firm sizes and returns in reality. In this light, the mathematical formulation of the VRS input-oriented model goes as follows.

$$\underset{\theta_k\ \lambda}{\text{Min}}\ \{\theta_k\}$$

subject to

$$\begin{aligned} -y_{jk} + Y\lambda &\geq 0 \\ \theta_k x_{ik} - X\lambda &\geq 0 \\ \lambda &\geq 0 \\ \textstyle\sum_n \lambda_n &= 1 \end{aligned} \qquad (1)$$

Where: θ denotes technical efficiency, x_{ik} stands for quantity of input $i = \{1,2, \dots, m\}$ consumed by firm$_k$ (k = 1, … , n), y_{jk} stands for quantity of output $j = \{1,2, \dots, s\}$ produced by firm$_k$. $X_k = \{x_{ik}\}$ of inputs. $Y_k = \{y_{jk}\}$ of outputs. λ is an n x 1 vector of firm weights. A constant return to scale (CRS) input-oriented model were also calculated (release the last constraint in equation 1) to find the SE score (from the ratio of CRS TE score and VRS TE score). To parameterize the model, a total of 22 Chinese T&A firms was selected in this study. All the firms are public firms, which were considered to represent the Chinese T&A industry. Among them, there are 8 firms from Men's wear, 6 firms from Women's wear and 8 firms from Sportswear. All the inputs and output information were derived from the annual report of each firm between year of 2013 to 2016. The results of DEA show that the average technical efficiency of the sampled firms is 0.7957 (range: 0~1), which is fairly high, meaning that firms can decrease their inputs by 20.43% and still produce the same output; the average scale efficiency of the sampled firms is 0.8808 (range: 0~1), which is high and means firms are close to their optimal size. In detail, TE score experienced a trough in 2014 and recovered later, and the SE score kept increasing at the first three years and maintained around 0.89 (see table 1). Moreover, Kruskal–Wallis Test results indicated that TE of Men's wear, Women's wear and Sportswear was significantly different in 2014 (x^2=11.67, df=2), 2015 (x^2=9.68, df=2) and 2016 (x^2=7.41, df=2), and Women's wear firms have the highest average score on TE than the others. There is no significant difference on SE in all the four years.

Table 1. Mean DEA efficiency scores

	Full Categories		Men		Women		Sport	
	TE	SE	TE*	SE*	TE*	SE*	TE*	SE*
2013	0.8148	0.8654	0.6442	0.8048	0.8047	0.9107	0.6126	0.784
2014	0.7543	0.8617	0.5072	0.8396	0.7692	0.8754	0.5428	0.8142
2015	0.7741	0.8990	0.5424	0.8832	0.7898	0.8874	0.5514	0.9194
2016	0.8396	0.8972	0.6564	0.8370	0.8211	0.8676	0.6516	0.9486
Mean	0.7957	0.8808	0.5875	0.8411	0.7962	0.8852	0.5896	0.8665

Note: * means bias-corrected.

This paper aimed at assessing the recent technical efficiency and scale efficiency of Chinese T&A firms. The findings showed that the T&A firms in sample had fairly high technical efficiency, meanwhile they have a remarkably high scale efficiency. This is contrary with Ye and Zhou's (2013) research, though, still suggested that Chinese T&A firms would set increasing TE as the priority and pay more attention to the utilization of resources, or technology updates, rather than increasing production scale. Moreover, the difference on TE between firm categories

warned that Men's wear and Sportswear firms may need urgent willing to improve their firm's performance.

Reference

Bhandari, A. K., & Ray, S. C. (2012). Technical efficiency in the Indian textiles industry: A non-parametric analysis of firm-level data. *Bulletin of Economic Research, 64*(1), 109-124.

Pfohl, H. C., & Shen, X. (2008). Apparel supply chain between Europe and China. *A Guide to Apparel Sourcing and Distribution in China.* Darmstadt.

Rangan, N., Grabowski, R., Aly, H. Y., & Pasurka, C. (1988). The technical efficiency of US banks. *Economics letters, 28*(2), 169-175.

Ye, M., & Zhou, X. (2013). Evaluation of competitiveness of China's textile and garments industry based on DEA Model. *Journal of Wuhan Textile University*, *26*(2), 5-9.