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THE EFFECT OF TRADE AND FOREIGN OWNERSHIP ON THE TECHNICAL EFFICIENCY OF INDONESIA'S TEXTILE INDUSTRY

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ABSTRACT

This study empirically examines the effect of trade (exports and imports) and foreign ownership on the technical efficiency of apparel industry in Indonesia from 2007 to 2013. Panel data and the maximum likelihood estimation approach to the stochastic frontier analysis (SFA) were applied for the analysis. While controlling for the spillover effect and firm size in the inefficiency model of the apparel industry, our empirical strategy indicates that the apparel industry has not yet reached the maximum level of technical efficiency. Export participation, foreign ownership, and spillover assert an increasing and significant influence on technical efficiency, while the import of raw materials asserts a negative and significant effect. Additionally, the mediation of exports and foreign ownership, and foreign ownership and firm size, increases the industry's technical efficiency, while the mediation effect of firm size and imports, and firm size and spillover, reduce the industry's technical efficiency. Recommendations based on the findings are outlined for policymakers.

Contribution/Originality: This study provides new insight by estimating the apparel industry's technical efficiency using the stochastic frontier analysis, taking into account the four main inputs in the production process (i.e., labor, raw materials, energy, and capital) and considering the influence of domestic and foreign competition.

1. INTRODUCTION

The textile and garment industry, commonly referred to as the textile and textile product industry, is an industrial sector with a linkage structure that was formed from a series of the industry from upstream to downstream. The textile industry cannot be easily separated from the apparel industry, which is generally part of the textile industry. As one of the oldest industries in Indonesia, it has a significant influence on the Indonesian economy (Salim & Ernawati, 2015). In 2019, the textile industry contributed 7.16% to the industrial GDP, indicating that the textile industry is one of the largest contributors to the manufacturing sector. In the last five years, the textile and apparel industry sub-sector has contributed an average of 1.17% per year to the GDP and 6.56% to the non-oil and gas processing industry (BPS, 2020). The cumulative production growth rate of the textile and apparel sub-sector ranged from -4.79% to 15.35% in the same period. Likewise, export performance in the same period also continued to climb in the range of 2.1–13.22 billion USD. Unfortunately, in 2019, the export value fell by 2.87% to 12.9 billion USD.

In addition to its role in the economy and exports, the apparel industry has also contributed to absorbing labor. According to the Ministry of Industry data, in 2018, this sector absorbed 3.6 million workers, which accounts for 2.9% of Indonesia's workforce. This industry is the second largest employer of labor, second only to the food industry, which accounts for 5.64% of employment. Because of its dominant role, the textile industry should be taken into account when developing future investments. Despite this record of high employment and rising trade in the textile industry, its growth stagnated during the period from 2011 to 2019. This is largely due to the 2009 global financial crisis and the lack of competitiveness of Indonesian textile products. The industry lost its competitiveness due to increased wages and input costs (Sugiharti, Rudi Purwono, Primanthi, & Padilla, 2019) and limited access to fixed capital (Javorcik, Fitriani, Iacovone, Varela, & Duggan, 2012). A lack of technical efficiency is another factor that weakens the competitiveness of the textile industry. While technical efficiency is a component of overall economic efficiency (Kumbhakar & Lovell, 2000), it can improve the competitiveness of the industrial sector.

In Indonesia over the last two decades, as a labor-intensive sector, the problem of increasing wages has been a problem for the textile industry. The industry is also heavily burdened by the weakening of the rupiah exchange rate because of the need to import raw materials. This has posed a very serious empirical question of whether to help this sector become more competitive and vice versa. Furthermore, energy prices are rising (doubled in the last decade), capital remains expensive, and the sector is characterized as a low technology-based sector. Only about 20% of industrial players have efficient machines that are in good shape, while the remaining 80% relies on aged machines for textile production (The Ministry of Industry, 2014). However, various government efforts still intend to accommodate the main problems and improve the efficiency of Indonesia's apparel industry.

In the current era of globalization, the role of trade and FDI in firms' efficiency has attracted much attention from researchers and policymakers. Javorcik et al. (2012) found that export-oriented firms, foreign-owned firms, and those well connected to global markets for imports tend to experience higher productivity growth, higher allocative efficiency, generate more jobs, and pay higher wages. According to Lemi and Wright (2020), exporting firms can minimize technical inefficiency. However, FDI is anticipated to benefit the host country because it brings new capital equipment, supports the development of production capacity, generates employment, and brings technological developments (Matthias & Javorcik, 2009). In addition, FDI has an indirect benefit for the host country, known as an externality (spillover) (Lu, Tao, & Zhu, 2017). The spillover effect from FDI can influence local industries by increasing their levels of efficiency. However, it is believed that foreign companies take market share from domestic companies through the phenomenon of market theft, which leads to higher production costs (Spencer & Spencer, 1993).

With this in mind, therefore, the goal of this study is to examine the influence of trade (exports and imports), foreign ownership, spillover, and firm size on technical efficiency in Indonesia's apparel industry. To achieve this, the study contributes to the literature by estimating the company's level of technical efficiency as a parameter of company performance using the stochastic frontier analysis (SFA) approach, taking into account the four main inputs in the production process (i.e., labor, raw materials, energy, and capital) and considering the influence of domestic and foreign competition (exports, imports, sizes, foreign ownership, and FDI spillover). Furthermore, the study also tests four production functions: Translog, Hicks-neutral (technology progress), non-technology progress, and Cobb–Douglas. Additionally, the study also includes interaction terms that help in capturing the mediation effect between trade openness, foreign investment, and total efficiency.

The other sections of this study are arranged as follows: Section two is the literature review, section three presents the data and methodology, section four discusses the main findings, and section five concludes the study and offered policy recommendations.

2. LITERATURE REVIEW

2.1. Theoretic

The efficiency of factor inputs in the production process can be analyzed through the use of the production function. Nicholson and Snyder (2010) define the production function as a functional relationship that shows the amount of input used to produce a given level of output. The inputs used in the production process are called productive factors, which are commonly known as capital, labor, land, and raw materials. Mathematically, the production function can be expressed as:

$$Q = f(K, L, E, M) \quad (1)$$

Where Q is the total productivity of the factor inputs, K is capital stock, L is the units of labor, E is energy consumption, and M is raw materials.

Equation 1 shows that the production process depends on the amount of capital, labor, energy, and raw materials used. The need for different production units results in different factors of production. Therefore, based on the process and purpose of production, the production function can be classified as a transcendental logarithmic production function (Translog), a Hicks-neutral production function (technological progress), or a Cobb–Douglas production function, among others.

The effectiveness with which factor inputs can produce a given amount of output is expressed by the technical efficiency. A company will be declared technically efficient if it can produce maximum output with minimum input. Technical efficiency is only one component of overall economic efficiency, as noted by Kumbhakar and Lovell (2015), which can be calculated using various methods. In this study, stochastic frontier analysis (SFA) was used, which was formulated by Aigner, Lovell, and Schmidt (1977). The production function of the stochastic frontier nature is expressed as:

$$lnq_i = x_i\beta + v_i - u_t \quad (2)$$

Where q_i is the firm $i's$ output level, x is the input combination used in the production process, β is the parameter to be estimated, v_i and u_t are two error terms in which v_i represents the firm statistical noise error component and u_t represents the technical inefficiency error component.

In the case of panel data, the SFA is structured with the influence of exogenous variables that may affect the company's technical efficiency. These exogenous variables come from the characteristics related to the company's condition (not from the input or final output). These characteristics include company size, degree of competence, and managerial characteristics, among others. To cover these variables, the SFA model is used in such a way that the model will include exogenous variables that can affect technical efficiency. This can be expressed as:

$$u_{it} = Z_{it}\delta + \omega_{it} \quad (3)$$

Where Z is the exogenous variables in firm i (i = 1, 2, …., N) in year t (t =1, 2, …., N), δ is the parameter of the technical inefficiency function, and ω is the white noise error term.

2.2. Empirical Review

Export activity will affect the industry's productivity. Export-oriented companies have higher productivity than companies that only sell their products in the domestic market (Haidar, 2012). Only efficient and productive companies can penetrate the export market (Sharma & Mishra, 2012). A company's participation in exporting goods is generally explained through the learning effect theory. There are additional costs from export activities that will decrease over time when a company enters the export market. This causes the company to gain net profits from export activities, which also increase over time.

Some empirical literature supports the nexus between exports and efficiency. For instance, Foster-McGregor, Isaksson, and Kaulich (2014) have, in the case of 19 Sub-Saharan African countries, observed evidence that efficiency is gained from learning effects, and concluded that more efficient self-selection by producers is the main reason for the variation in productivity between exporters and non-exporters in the manufacturing and services sectors. Granér and Isaksson (2009) investigated the nexus between exports and the efficiency of manufacturing firms in Kenya. Their finding revealed that non-exporting firms are less efficient than exporting firms. In another study, Granér (2002) revealed no significant difference either in technical efficiency or scale efficiency between factories regarding export history in the Chilean manufacturing sector. However, relatively efficient non-exporting firms are more likely than inefficient firms to enter export markets; that is, export companies were relatively efficient before they became exporters. Haidar (2012) reported similar findings for the Indian manufacturing sector. In the case of small and medium Thai manufacturing enterprises, studies by Charoenrat, Harvie, and Amornkitvikai (2013) and Charoenrat and Harvie (2017) found exports, foreign direct investment, and type of ownership to be significant factors influencing technical efficiency.

According to Nurhadi (2014), importing increases competition in the domestic market due to an increase in market players. In the case of Indonesia, Widiati (2005) applied the structure–conduct–performance (SCP) approach to examine the performance of the textile and textile product industry from the period between 1996 and 2001. Their empirical strategy indicated that the performance of the textile industry is comparatively higher relative to the entire manufacturing sector. Furthermore, industry concentration, company size, and raw materials imports were the key determinants of company productivity and efficiency. Similarly, Mazumdar and Rajeev (2009) showed that a company's integration with the upstream sector, raw materials imports, and technology tend to promote productivity and efficiency. Moreover, raw materials imports are not fully associated with improved efficiency because of the dependency effect, in which case high dependency on imports can make the industry more vulnerable to exchange rate fluctuations. More importantly, the high cost of raw materials due to exchange rate fluctuations negatively affects industrial performance Asmara, Purnamadewi, and Meiri (2013).

Moreover, there is a general argument about the efficiency of foreign firms over domestic firms in the host country (Buckley, Wang, & Clegg, 2010). This depends purely on how the most productive and efficient companies choose to operate and establish subsidiaries in other countries. The presence of efficient foreign firms has an impact on domestic firms. This is supported by Lemi and Wright (2020), who observed that foreign ownership significantly affects the efficiency of domestic companies. Their study further revealed that domestic firms with a higher share of foreign ownership have better technical efficiency. Similarly, Svedin and Stage (2016) observed a positive impact of foreign ownership on the efficiency level of the Swedish manufacturing sector. The presence of foreign ownership will facilitate local partners in developing the production process. A foreign company is expected to have some intangible assets, which include new technologies, managerial skills, marketing expertise, brands, patents, and networks of cooperation with other partners connected with foreign companies. Furthermore, an indirect pathway of FDI effect on firms' efficiency can be seen from the spillover effect. Most empirical studies on the nexus between FDI and efficiency were based on the concept of externalities or the spillover effect. The spillover effect can originate horizontally, i.e., from inside the same investment in the form of the demonstration effect, competition, and the mobility of labor (Takii, 2011). Many previous studies that examined the link between efficiency and FDI in Indonesia revealed that FDI increases efficiency through horizontal spillover. For instance, Javorcik (2004) established a positive nexus between FDI spillover and productivity in Lithuania. Correspondingly, Suyanto and Salim (2013) investigated the impact of spillover on the efficiency of the technical nature of the pharmaceutical industry in Indonesia. Their empirical strategy based on the stochastic frontier analysis (SFA) and the data envelopment analysis (DEA) revealed that the existence of foreign investment negatively affects the technical efficiency of the pharmaceutical industry but asserts a beneficial spillover effect on domestic firms which were found to be less efficient than foreign firms.

On the link between firm size and technical efficiency, Bhandari and Ray (2012) observed a significant positive impact of firm size on the technical efficiency in the case of the Indian textile manufacturing industry. Halkos and Tzeremes (2007) found an indirect effect of firm size on productivity and efficiency in the Greek manufacturing sector, while Chapelle and Plane (2005) observed that firm size is the main determinant of productive efficiency in the textile and garments industry in the Côte d'Ivoire. Over the period from 1993 to 2000, Margono and Sharma (2006) applied the SFA and total factor productivity (TFP) and examined the factors influencing inefficiency in the Indonesian metal, chemical, textile, and food industries. Their finding indicates that size and firm location add to technical inefficiency in the textile industry and the industry experienced a 0.26% decline in productivity as indicated in the TFP growth.

3. METHODOLOGY AND DATA

In this study we used a parametric quantitative approach along with the stochastic frontier analysis (SFA) to calculate the value of a company's technical efficiency in the apparel industry. Technical efficiency and its determinants were estimated using maximum likelihood estimation (MLE). The data used in this study are secondary micro firm-level panel data for Indonesia's textile industry from 2007 to 2013. The data were collected and adjusted to obtain the required information with observations for a total of 728 companies. For the estimate of industry technical efficiency, the study used the translog Model (4), which is expressed in the following form:

$$LnY = \beta_0 + \beta_K(LnK)_{it} + \beta_L(LnL)_{it}u_{it}) + \beta_M(LnM)_{it} + \beta_E(LnE)_{it} + \frac{1}{2}\beta_{KK}LnK_{it}{}^2 + \frac{1}{2}\beta_{LL}LnL_{it}{}^2 + \frac{1}{2}\beta_{MM}LnM_{it}{}^2 + \frac{1}{2}\beta_{EE}LnE_{it}{}^2 + \beta_{KL}(LnK)(LnL)_{it} + \beta_{KM}(LnK)(LnM)_{it} + \beta_{KE}(LnK)(LnE)_{it} + \beta_{LM}(LnL)(LnM)_{it} + \beta_{LE}(LnL)(LnE)_{it} + \beta_{ME}(LnM)(LnE)_{it} + \beta_{kt}(K)_t + \beta_{lt}(L)_t + \beta_{mt}(M)_t + \beta_{et}(E)_t + \beta_t t + \frac{1}{2}\beta_t t^2 + v_{it} - u_{it} \quad (4)$$

Where *i* is the individual firm component, *t* is the year of observation, *Y* is the firm output level, *K* is the stock of capital, *L* is the labor employed, *M* is the material used, *E* is the energy used, the βs are the coefficients to be estimated, *v* represents the error term, and *u* is the technical inefficiency component.

After estimating the industry's technical efficiency using translog Model (4) and SFA, the study further analyzed the effect of the tested exogenous variables on the technical efficiency of the textile industry. This was done by further estimating the technical inefficiency model, expressed in Model (5) as:

$$u_{it} = \delta_0 + \delta_1 Exp_{it} + \delta_2 Imp_{it} + \delta_3 Fo_{it} + \delta_4 Spill_{it}\ \delta_5 Fsize + \omega_{it} \quad (5)$$

Where *u* is the technical inefficiency term, *Exp* is the export activity participation dummy (*1* if firm *i* is exporting output and *0* otherwise), *Imp* is the raw materials import ratio measured by the ratio of imported raw material and the total input used in firm *i*'s production process expressed in rupiah, *Fo* is foreign ownership measured by foreign investment (this is measured by a dummy variable with a value of 1 if foreign investment in firm *i* exceeds 10% of its total investment and 0 otherwise), *Spill* is the spillover effect measured by the ratio of foreign firms' output to the total industry output, *Fsize* is the firm size calculated by the ratio of a firm's output to the total output of the industry, and ω is the unobservable error component. The extent to which these variables can affect the efficiency of the textile industry in Indonesia is captured by $\delta_1, \delta_2, \delta_3, \delta_4,$ and δ_5.

Model (5) is the baseline inefficiency model which can be further developed by incorporating interaction terms derived from trade variables (export and import), foreign direct investment, and firm size. In addition to the estimate of the translog model, three additional models will also be estimated. This is important because the SFA requires a specific and flexible functional form to reduce the risk associated with model error. These additional models include Hicks-neutral (technology progress), non-technology progress, and Cobb–Douglas, which were estimated and compared with the translog model. Moreover, for the feasibility of the translog model, three additional null hypotheses that are associated with the Hicks-neutral (technology progress), non-technology progress, and Cobb–Douglas models will be tested.

Therefore, to test whether the Hicks-neutral model is feasible and compatible with the study data, we verify the null hypothesis of the second-order parameter equal to zero ($\beta_{kt} = 0$). Furthermore, for the non-technology progress model, we use the null hypothesis of the interaction between the input coefficient and time ($\beta_t = \beta_{tt} = \beta_{kt}$). The interaction of time on the zero-input coefficient means that there is no technological progress. In the Cobb–Douglas sub-model, the null hypothesis occurs when the second-order parameter is equal to zero, i.e., $\beta_{kl} = \beta_{kt} = \beta_t = \beta_{tt} = 0$.

By and large, to use a feasible stochastic production function, a generalized log-likelihood ratio test will be used, which is expressed as:

$$Ʌ = 2[l(H_0) - l(H_1)] \quad (6)$$

Where $l(H_0)$ is the value of the log-likelihood of production function sub-models, $l(H_1)$ is the log-likelihood value of the translog model, i.e., Model (5). A higher value of the log-likelihood ratio (LR) will reject the null hypothesis, whereas a lower value of the log-likelihood ratio (LR) will fail to reject the null hypothesis. On the other hand, the significance of the parameter of the baseline Model (5) will be tested using the t-statistic test, which is perfected by comparing the t-ratio with the t-table based on the following hypotheses:

H_0: $\beta = 0$, then the explanatory variable has no significant effect on the regressand.

H_1: $\beta \neq 0$, then the explanatory variable has a significant effect on the regressand.

A t-ratio that is greater than the t-table will reject the null hypothesis of the non-significant explanatory variable, in which case we can conclude that the explanatory variable has a significant effect on the regressand.

4. RESULTS AND DISCUSSION

In this part of the analysis, the measurements of technical efficiency of the apparel industry were carried out through the use of the SFA. Figure 1 shows the results and calculated values of the technical efficiency in the textile and apparel sub-sector industry. The industry consists of 14 main categories, and seven years (2007–2013) of data were applied for analysis. The estimated technical efficiency has a fluctuating annual observation, indicating that the industry has not been able to sustainably maintain its productive efficiency. The average estimated annual observation of technical efficiency is represented by the horizontal line in Figure 2, with a value of 0.877. This weighted average represents a low level of technical inefficiency. Any annual estimate of technical efficiency that falls below the average estimate indicates technical inefficiency.

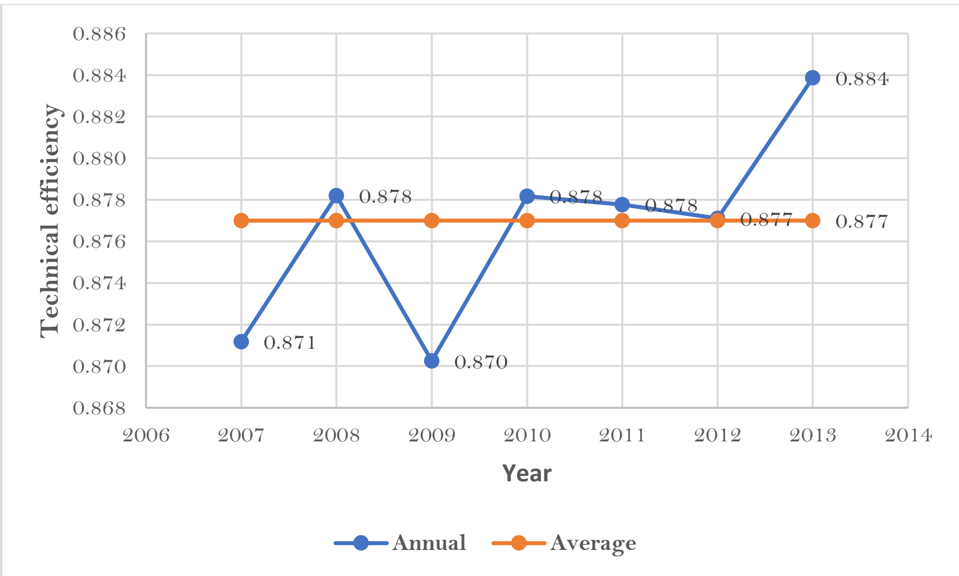

Figure 1. Apparel industry's average technical efficiency.

Table 1. Results of maximum likelihood estimation (MLE).

Production function: The dependent variable is output (Y)				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Constant	6.552*** (0.300)	7.049*** (0.338)	7.461 *** (0.279)	9.254*** (0.146)
k	0.180*** (0.039)	0.141*** (0.044)	0.120*** (0.039)	0.159*** (0.010)
l	0.3900*** (0.062)	0.432*** (0.064)	0.477*** (0.065)	0.659*** (0.014)
m	- 0.081*** (0.016)	- 0.120*** (0.018)	- 0.125*** (0.016)	0.104*** (0.003)
e	0.189*** (0.026)	0.206*** (0.026)	0.209*** (0.026)	0.113*** (0.006)
kl	0.017*** (0.006)	0.014*** (0.006)	0.010*** (0.006)	---
km	- 0.017*** (0.002)	- 0.017*** (0.002)	- 0.016*** (0.002)	---
ke	- 0.025*** (0.003)	- 0.023*** (0.003)	- 0.023*** (0.003)	---
lm	- 0.034*** (0.002)	- 0.032*** (0.002)	- 0.031*** (0.002)	---
le	- 0.004 (0.004)	- 0.002 (0.004)	0.001** (0.004)	---
me	- 0.005*** (0.001)	- 0.006*** (0.001)	- 0.007*** (0.001)	---
kk	0.010*** (0.002)	0.010*** (0.002)	0.012*** (0.002)	---
ll	0.008 (0.007)	0.007 (0.007)	0.002 (0.007)	---
mm	0.041*** (0.000)	0.042*** (0.000)	0.042*** (0.000)	---
ee	0.017*** (0.001)	0.017*** (0.002)	0.016*** (0.001)	---
t	0.157*** (0.030)	0.054*** (0.003)	---	---
tt	0.001 (0.002)	---	---	---
kt	- 0.009*** (0.003)	---	---	---
lt	0.009*** (0.004)	---	---	---
mt	-0.007*** (0.001)	--	---	---
et	0.008*** (0.001)	---	---	---
Technical inefficiency model estimate: The dependent variable is technical inefficiency				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Constant	0.144*** (0.034)	0.108*** (0.021)	0.249*** (0.044)	1.723*** (0.095)
Exp	-0.074** (0.034)	-0.124*** (0.048)	-0.084*** (0.024)	0.050*** (0.034)
Imp	0.143** (0.075)	-0.100** (0.085)	0.265** (0.064)	0.356*** (0.097)
Fo	-0.119** (0.068)	-0.286*** (0.094)	-0.130*** (0.057)	-0.441*** (0.063)
Spill	-1.536* (1.110)	-0.910** (0.886)	-0.030* (0.022)	0.003*** (0.012)
Fsiize	-6.716*** (2.341)	-0.029** (0.016)	-0.077*** (0.030)	-0.005*** (0.022)
Sigma squared	0.187 (0.004)	0.193 (0.004)	0.199 (0.004)	0.621 (0.013)
Gamma	0.029 (0.005)	0.022 (0.022)	0.027 (0.009)	0.324 (0.024)
Log-likelihood function	-2938.47	-2998.86	-3130.87	-5989.24
No. of observations	5096	5096	5096	5096

Note: Model 1 is the translog production function, Model 2 is the Hicks-neutral production function, and Model 3 and Model 4 are the non-technological and Cobb–Douglas models. The values in parentheses are the standard errors. Significance levels are denoted by *** p < 0.01, ** p < 0.05 and * p < 0.1.

The impact of the exogenous variables on the level of industry inefficiency was estimated based on the frontier production function in Model (6). In Table 2, except for the import ratio, all the estimated coefficients assert a negative and significant impact on technical inefficiency in all model estimates. This implies that these variables increase the industry's technical efficiency. The coefficient of the export dummy, which measures the industry's participation in the export market, is negative and statistically significant at a 5% level. This finding implies that the export-oriented apparel firms operate more efficiently than firms that only sell in the domestic market. This finding is supported by Sharma and Mishra (2012) and Haidar (2012), who observed that export-oriented firms tend to have higher productivity than firms that only sell their products in the domestic market. The import ratio shows a positive and significant effect on technical inefficiency, or a negative effect on technical efficiency. This result contradicts previous studies, such as Mazumdar and Rajeev (2009), Nurhadi (2014) and Suatmi, Bloch, and Salim (2017), who reported that importing raw material increases the industry's technical efficiency. However, our finding is supported by Asmara et al. (2013), who observed that the cost of imported raw materials negatively affects the performance and efficiency of the textile industry. This finding is more appealing because high dependence on raw materials imports can negatively affect industrial production due to exchange rate fluctuations and government liberalization policy. This finding is also relevant to Indonesia because the country lacks sufficient cotton and polyester fibers required by the textile industry. This posed a very serious threat to the increasing efficiency of the textile industry. The domestic market also concentrates on firms within the industry that can import raw materials, which leads to the monopoly power effect. This monopoly power causes a less competitive business environment and reduces industrial technical efficiency. The foreign ownership (*Fo*) and spillover (*Spill*) variables have a negative and significant effect on technical inefficiency. This finding provides strong evidence that foreign companies operate more efficiently than domestic companies, and their entry into Indonesia's textile industry promotes competition thereby encouraging domestic companies to improve their technical efficiency to maintain market share. These findings are consistent with studies by Orlic, Hashi, and Hisarciklilar (2018) and Liang (2017) among others, who concluded that FDI causes a reduction in technical inefficiency. Firm size reduces the inefficiency level significantly at less than 1% level of significance. This indicates that large firms are more efficient relative to small firms in Indonesia's textile industry. This is because large firms are more likely to have access to modern techniques of production resulting from the diffusion of technology. This finding is in line with Bhandari and Ray (2012), who revealed a positive nexus between technical efficiency and the size of the industry.

Furthermore, our empirical strategy in Table 2 with mediation effects shows mixed findings. The mediation effects of exports and imports ($Exp \times Imp$), exports, and spillover ($Exp \times Spill$) are negative but statistically insignificant, while the mediation effect of exports and firm size ($Exp \times Fsize$) is positive and statistically insignificant. These findings imply that there is no evidence of an indirect effect of export–import, export–spillover, and export–firm size on the industry efficiency level. Additionally, the effect of exports interacted with foreign ownership ($Exp \times Fo$) has a significant negative effect and reduces the level of industry inefficiency. This finding implies that foreign firms that participate in export activities improve the technical efficiency of Indonesia's textiles industry. This finding is consistent with Haidar (2012) and Vinh and Duong (2020). Foreign ownership interacted with import, spillover, and firm size shows significant effects. The interaction effects of foreign ownership and imports ($Fo \times Imp$), foreign ownership, and spillover ($Fo \times spill$) are positive and statistically significant.

This finding indicates that foreign firms with a high ratio of imported raw materials tend to be more technically inefficient. Meanwhile, the presence of foreign firms is associated with an increased spillover effect and decreased efficiency. This evidence contradicts Liang (2017), who reported that, through knowledge transfer, the presence of foreign firms will increase the efficiency of domestic firms. Spencer and Spencer (1993) also explained that the entry of foreign firms may result in increased competition, which may result in increased costs due to the bidding for workers and resources, leading to increase inefficiency. The interaction effect of foreign ownership and firm size ($Fo \times Fsize$) reduces the inefficiency level. This implies that foreign ownership with a larger firm size reduces the technical inefficiency in Indonesia's textiles industry.

Table 3. MLE estimates of the technical inefficiency with interaction variables.

Technical inefficiency model: The dependent variable is technical inefficiency				
Variable	**Coefficient**	**T-ratio**	**Sigma squared**	**Gamma**
$Exp \times Imp$	-0.326 (0.258)	-1.260	0.189	0.026
$Exp \times Fo$	-0.353*** (0.188)	-1.878	0.188	0.020
$Exp \times Spill$	-0.426 (0.9975)	-0.427	0.188	0.023
$Exp \times Fsize$	0.463 (0.014)	0.338	0.187	0.040
$Fo \times Imp$	0.574*** (0.244)	2.346	0.188	0.023
$Fo \times Spill$	3.404* (0.249)	1.370	0.188	0.054
$Fo \times Fsize$	-0.783* (1.120)	-6.993	0.187	0.032
No. of observations	5096	5096	5096	5096

Note: The values in parentheses are the standard errors. Significance levels are denoted by *** $p < 0.01$ and * $p < 0.1$.

5. CONCLUSION AND POLICY IMPLICATIONS

This study examines the effect of trade (export and import), foreign ownership, spillover, and firm size on the technical efficiency of Indonesia's textile industry from 2007 to 2013. Our empirical strategy based on different production functions and the stochastic frontier analysis revealed that technical efficiency has fluctuated over the years, indicating that the industry has not been able to sustainably maintain its productive efficiency. The average technical efficiency is 0.877 in Indonesia's textile industry for the period under study. This implies that the industry average is 87% and indicates that it is operating below the potential production with a 13% gap signifying technical inefficiency. This gap, though low, can reduce the productivity of the apparel industry. Our findings demonstrate that export participation positively affects technical efficiency. This further explains that firms within the industry partaking in export activities increases the industry's technical efficiency. Except for the Cobb–Douglas production function, this finding remained robust and consistent in all estimated models (see Table 1). As evidenced from the empirical findings, the raw materials import ratio reduces technical efficiency, in which case dependence on imported raw material can hinder technical efficiency due to the high cost associated with importing raw materials.

The effect of foreign investment was examined using foreign ownership and horizontal spillover and revealed a significant negative effect on technical inefficiency. This implies that foreign investment increases technical efficiency either through foreign ownership or through the spillover effect of foreign firms. Similar results were also found in large firms, in which firm size reduces technical inefficiency. For the mediation effects in the inefficiency model, while the import-oriented firms have been found to reduce technical efficiency, the export-oriented foreign firms in the industry increase technical efficiency. A similar result was found in larger foreign companies, which increase technical efficiency. Based on the study findings, we recommend that the government should give more incentives to textile manufacturers to enable them to export more textiles that are made in Indonesia. This can be achieved by reducing export duties and the associated bureaucracy when it comes to "made in Indonesia" textile exports since raw material imports reduce technical efficiency in the industry. There is a need for the government to bridge the gap in raw materials required by the domestic industry through an import substitution policy. In doing so, local raw materials will be made available for use in the textile industry, and this will help to reduce technical inefficiency. The inflow of FDI, especially export-oriented foreign investment, should be encouraged by giving incentives to foreign investors in terms of tax cuts, tax holidays, an enabling environment, and easing the procedures for initial take-off to start a business in Indonesia. Business expansion should also be encouraged in the industry by providing credit facilities and the necessary infrastructure that will enable smaller firms to grow. There is also a need for the merging and acquisition of small firms to form a single larger entity to improve technical efficiency.

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