FOREIGN DIRECT INVESTMENT- PRODUCTIVITY GROWTH NEXUS: EVIDENCE FROM FOOD AND BEVERAGES, TEXTILES AND GARMENTS SUBSECTORS MANUFACTURING SUBSECTORS IN INDONESIA

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Abstract

It is argued that Foreign Direct Investment (FDI) can increase productivity by improving technical efficiency. This study has attempted to identify the other determinants of technical efficiency and Total Factor Productivity (TFP) growth over and above FDI in the three biggest manufacturing sectors in terms of employment generation - food and beverages, textiles and garments subsectors from 2004 to 2009. Stochastic Frontier Analysis (SFA) under a panel data framework was implemented to address the above objectives. This study found that these subsectors are less efficient with mean technical efficiency of 83 per cent and TFP growth between -1.78 per cent and 1.11 per cent. The results indicate that FDI representing the foreign-owned status, industrial area and firm's size in term of output contributed positively to technical efficiency and TFP growth. In contrast, horizontal spillovers and fiscal incentives were found to have a negative effect on technical efficiency and productivity growth. Given the results that FDI and industrial location can boost firms' performance, the Indonesian government could attract more FDI by implementing a new scheme such as a tax holiday on approved projects instead of reduction on tax income for investment. In addition, the number of industrial locations should be increased.

Keywords: Foreign Direct Investment, Stochastic Frontier Analysis, panel data, technical efficiency, TFP growth.

1 INTRODUCTION

Indonesia, one of the countries with the richest natural resources, is home to 230 million people or 3.4 per cent of the world's population. Despite its abundant resources, Indonesia is listed among the lower middle income countries with only USD 2,254 per capita income in 2008 and close to half of people (over 110 million people) live on less than US $2 a day (Suryahadi et al. 2012). These people are exposed to many kinds of shocks, such as sudden price increases, loses of employment or illness. Therefore, the Indonesian government has been trying to reduce poverty by creating more employment opportunities (Suryahadi et al. 2012). One potential sector, which can provide more employment, is the manufacturing sector, which contributed more than a quarter of Indonesian GDP in the period 2004-2009.

Furthermore, manufacturing employed more than 12.5 million Indonesians in 2008, representing an overall increase of nearly 1 million manufacturing jobs since 2000 (Rahardja & Winkler 2012). Food and beverages, textiles and garments sectors are the three biggest subsectors creating employment opportunities (Indonesian Central Bureau 2011). It is important that these sectors perform consistently with full technical efficiency, because when these sectors are fully technical efficient, there will not be any wastage of inputs in the output production. The more inputs they use the larger output they achieve (Grafton et al. 2003) which should be good for economic performance.

Foreign direct investment (FDI) is argued as an important factor in improving efficiency and productivity gains through positive spillovers such as technology transfer and human capital development (Investment Coordinating Board of the Republic of Indonesia 2010). Hymer (1960) argued that FDI provides direct benefits by additional capital and employment and indirect benefits from the positive externalities of the foreign firm. FDI that can be manifested as Multinational Corporation can generate three important spillovers; efficiency or productivity spillovers, pecuniary spillovers and market-access spillovers (Blomstorm & Koko 1996). Furthermore, FDI can generate horizontal and vertical linkages. Vertical linkages show the connection between sellers and producers in the recipient country, while horizontal linkages imply the relationship between the competing and complementary firms in the same industry. However, this study focuses on FDI's productivity spillovers and horizontal linkages, which may generate an increase in efficiency and productivity in domestic and foreign firms in Indonesia's food and beverages, textiles and garments sector in the period 2004-2009.

Several empirical studies investigating FDI spillovers illustrate mixed evidence of FDI spillovers in recipient countries especially in manufacturing sectors. The presence of foreign firms could affect an increase in productivity growth of local firms in Mexico (Blomstrom & Kokko 1996). The positive spillovers on local firm's productivity has also been found in some empirical studies such as Chakrborty and Nennenkam (2008), Gorg and Strobl (2005) and Schiff and Wang (2008). However, Haddad and Horrison (1993) argue that foreign firms did not accelerate domestic firm's productivity in Morocco during the 1980s. Similar results were also found in Poland manufacturing sector from 1976-1989 (Gagelman 2000)

The effect of FDI on manufacturing sector has also been examined in Indonesia. Using firm level data in 1991, Blomstrom and Sjoholm (1999) demonstrate that labor productivity of local firms increased due to the presence of foreign ownership firms. Furthermore, Dhanani and Hanain (2002, 1354) argue that FDI generated total capital formation, net export revenue, tax revenue and technology transfer for Indonesian manufacturing sectors from 1985 to 2000.
Technical efficiency and Total Factor Productivity (TFP) growth are other concerns in this study. Some previous studies have observed these two components in manufacturing sectors. Wadud (2004) investigates that the level of technical efficiency in Australian textile and clothing firms depended on firm's age, output size, capital intensity and legal status. Moreover, Hill and Kalirajan (1993) argue that technical efficiency is positively correlated with export, financial integration and working female. They also find that labor and capital were substitution inputs in this industry.

Several studies examined performance of TFP growth in some sectors. For example, China's agricultural sector experienced negative TFP growth before the reform period and positive TFP growth after the reform period (Kalirajan et al. 1996). In Indonesia's manufacturing industries case, by implementing a growth accounting method to measure TFP growth, Timmer (1999) observed that Indonesian manufacturing sectors faced 2.8 per cent of TFP growth in the period 1975-1995. Furthermore, TFP grew averagely at rate 2.3 per cent in 28 Indonesian manufacturing sectors from 1975 to 1993 (Aswicahyono & Hill 2002). Furthermore, in the period 1993-2002, TFP growth across Indonesian provinces declined by 7.5 per cent due to technical inefficiency (Margono et al. 2011).

The technical efficiency can be measured by Data Envelpoment Analysis (DEA) and stochastic frontier analysis (SFA) (Coelli et al. 2003, p. 183). There are some differences between these two methods. The major difference is that the stochastic frontier is a parametric estimation, while DEA is non-parametric. Furthermore, SFA provides standard errors of production coefficients whereas DEA cannot provide standard errors of (Bera & Sharma 1999 cited in Margono & Sharma 2006, p. 981). Similarly, TFP growth estimation can be estimated in two ways; growth accounting and production function estimation. However, growth accounting approaches assume full technical efficiency and technological progress and TFP growth are synonymously used. On the other hand, the production function method can estimate TFP growth without the assumption of full technical efficiency and decompose its components (Margono & Sharma 2006, p.981).

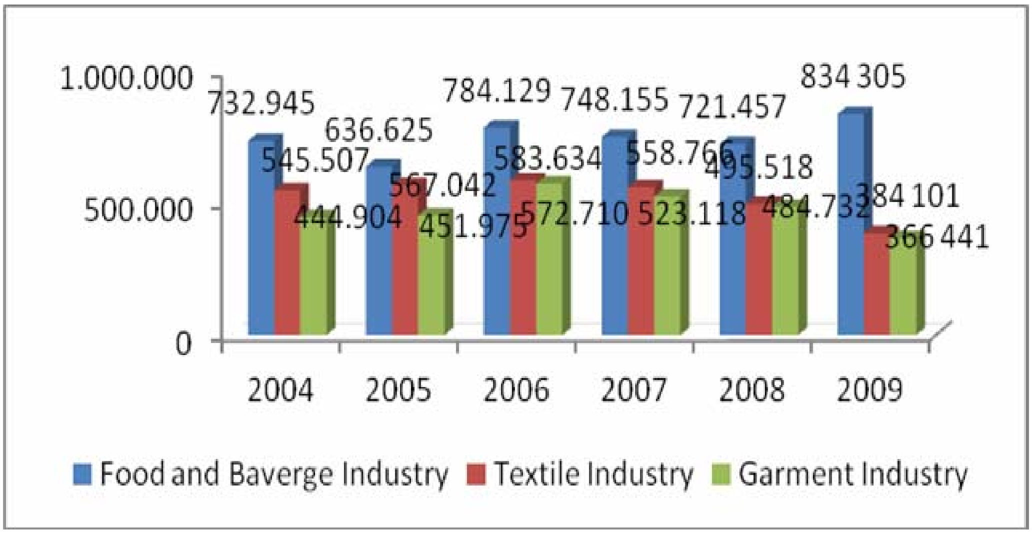
The effect of FDI spillovers on technical efficiency and productivity growth has been examined in several studies, which show mixed evidence. However, there are some gaps in the literature. First, generally firm level studies of FDI spillovers in Indonesia's manufacturing sector have been observed by pooling all manufacturing firms together or only one sector. This study contributes by examining disaggregated firms using five digits International Standards Industrial Clasification (ISIC) in the three biggest subsectors that provide job opportunities. Second, this study implementes Stochastic Frontier Analysis to decompose TFP growth drawing on the Malmquist's index that solves the limitations of the growth accounting model. Furthermore, there is no study that includes government interventions in the FDI spillovers model. Hence, the objectives of this study are to estimate the determinants of technical efficiency with a particular emphasis on examining the role of FDI to productivity growth in food and beverages, textiles, and garments sector in Indonesia from 2007 to 2012.

The remainder of the paper is organized as follows. Section 2 presents an overview of the three biggest subsectors. The data and methodology are discussed in Sections 3 and 4. The results of the study are presented in Sections 5. Discussion is presented in Section 6. Section7 concludes this study.

2 OVERVIEW OF THREE BIGGEST MANUFACTURING SUBSECTORS.

The important role of the food and beverages, textiles and garment manufacturing sectors to Indonesia's economy can be examined by its share of manufacturing employment. In 2004, more than 700.000 people were employed in food and beverages sector. The number of workers in the food industry rose from 2004 to 2009. Furthermore, textiles and garment industries also supplied large job opportunities. From 2004 to 2008 the number of labor engaged in these sectors increased. However, in 2009, the number of employed in these industries decreased. The numbers employed d in the three biggest manufacturing sectors is reported in Figure 1.

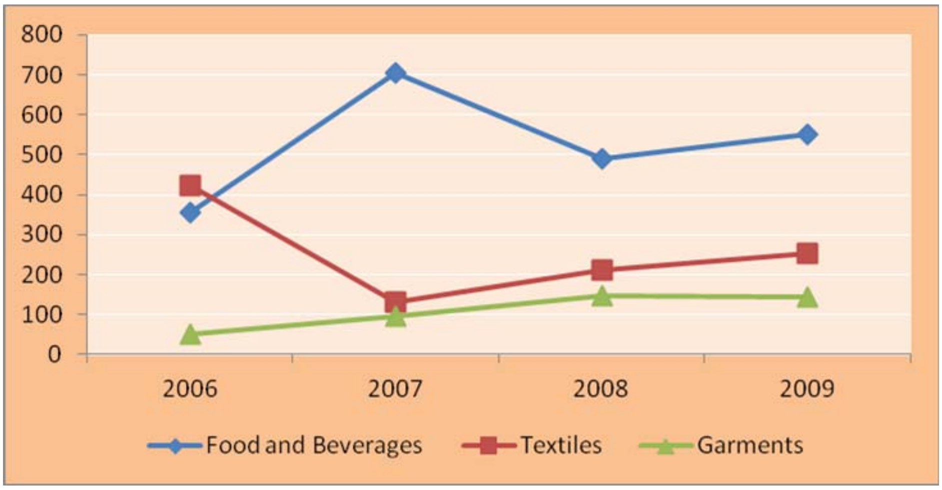
Figure 1: Number of labor employed in the three biggest manufacturing subsectors, 2004-2008



Source: Indonesian Central Bureau (2011), Statistic Indonesia Press ReleaseNo 10/02 Year XIV.

From figure 2, it can bee seen that generally FDI inflow to the three biggest manufacturing sectors increased from 2006 to 2009. The food and beverages sector achieved the highest inflow among others. However in 2008 when the global financial crisis occurred, the amount of FDI inflow dropped dramatically from US$ 700 million to US$ 500 milion. On the other hand, the garment industry had the lowest FDI inflow during this period. However, in this sector the trend of FDI inflow increased over the period. Interestingly, the amount of foreign investment in the garment sector was not affected by the global financial crisis in 2008.

Figure 2: Foreign Direct Investment (FDI) Inflow (US$ million), 2006-2009



Source: Indonesian Ministry of Finance (2012), The Statistics of Economics Vol. 1 No 5.

3 DATA

The balanced panel data method was implemented to estimate the SFA in the Indonesia's three biggest subsectors; food products and beverages (ISIC 15), textiles (ISIC 17) and garment sectors (ISIC 18). Individual firm data from 2007 to 2012 was obtained from Indonesian Yearly Large and Medium Manufacturing Industries survey conducted by the Indonesian Central Bureau of Statistics. Wholesale price index (WPI) was used to deflate monetary variables. Some observations with missing values and inconsistency of industrial code were deleted from the sample. After the adjustment process, the observations were 25,698 consisting of 4,283 firms for six years. The summary statistics for the main variables used are presented in Table 1.

Table 1: Summary Statistics

	Mean	**Std. Dev.**	**Min**	**Max**
Output	49500000	238000000	86000000	11000000000
Capital	53300000	2460000000	20000000	210000000000
Labor	245	805	20	40850
Material	39700000	216000000	72000000	9800000000
Owberships	-0.66	0.59	-1	1
Location	0.32	0.47	0	1
Size	0.10	0.31	0	1
Horizontal	15.29	113.88	0	5141.27
Fiscal	0.28	0.45	0	1

4 METHODOLOGY

A stochastic frontier approach

The maximum output that can be achieved under the available technology with the input set is estimated defining a frontier production function. If firms work on the frontier, they are fully technical efficient. The Stochastic Frontier Analysis can be implemented to estimate a production function and an inefficiency function (Battese and Coelli 1995, p. 329).

Following Kalirajan and Shand (1996, p. 15), the production frontier can be explained as

$$Y_{it} = f\,(x_{it},\ t;\ \beta).\ Exp(vi_{it} - u_{it}) \qquad (1)$$

Where y_{it} is the i'th firm's output in t period, xit is inputs vector, and β is estimated parameters. The assumptions for the error term (v_{it}) are independent and identical distribution, N (0, σ_v^2). Technical inefficiency is represented by *uit*, which is assumed as a firm-specific, non-negative, and independent distribution but zero truncated of the normal distribution.

Battese and Coelli (1995, p. 329) argue that technical inefficiency's determinations can be estimated as:

$$u_{it} = z_{it}\delta + \omega_{it} \qquad (2)$$

With z_{it} is the explanatory variables vector, δ is a vector of estimated unknown parameters and ω_{it} is observable random variables with assumption of the truncated of the normal distribution.

Variance terms are estimated by substituting σ_v^2 and σ_u^2. Following Battese and Coeli (1993) variance terms can be calculated as:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \text{ and } \gamma = \frac{\sigma_u^2}{(\sigma_v^2 + \sigma_u^2)} \quad (3)$$

Functional forms of study

Stochastic frontier analysis can be estimated by any functional form of the production function. In order to reduce the risk of errors in the model specification, a flexible production function such as translog model can be implemented (Suyanto & Bloch 2009, p. 1866). The translog production function used in this study can be defined as:

$$lny_{it} = \beta_0 + \beta_c lnc_{it} + \beta_l lnl_{it} + \beta_m lnm_{it} + \beta_t t + 1/2\,[\beta_{cc}(lnc_{it})^2 + \beta_{ll}(lnl_{it})^2 + \beta_{mm}(lnm_{it})^2 + \beta_{tt}(t)^2] + \beta_{cl} lnc_{it}*lnl_{it} + \beta_{cm} lnc_{it}*lnm_{it} + \beta_{lm} lnl_{it}*lnm_{it} + \beta_{ct}\, t*lnc_{it} + \beta_{lt}\, t*lnl_{it} + \beta_{mt}\, t*lnm_{it} + v_{it} - u_{it} \quad (5)$$

The Implementation of the translog model may not be an appropriate functional form to represent the data in the study. Therefore, various sub models of functional forms such as; Hicks-Neutral technological progress, no-technology progress in the production frontier, Cobb Douglas with efficiency model and Cobb Douglas without efficiency model, should be considered and tested (Suyanto & Bloch 2009, pp. 1866-1867). The functional forms in this study are described in Table 2

Table 2: Functional Form of Production Functions

Sub-Model	**Functional Form**	**Null Hypothesis**
Hicks-Neutral technological progress	$lny_{it} = \beta_0 + \beta_c lnc_{it} + \beta_l lnl_{it} + \beta_m lnm_{it} + \beta_t t + 1/2\,[\beta_{cc}(lnc_{it})^2 + \beta_{ll}(lnl_{it})^2 + \beta_{mm}(lnm_{it})^2 + \beta_{tt}(t)^2] + \beta_{cl} lnc_{it}*lnl_{it} + \beta_{cm} lnc_{it}*lnm_{it} + \beta_{lm} lnl_{it}*lnm_{it} + v_{it} - u_{it}$	$\beta_{nt} = 0$
No-technology progress in the production frontier	$lny_{it} = \beta_0 + \beta_c lnc_{it} + \beta_l lnl_{it} + \beta_m lnm_{it} + 1/2\,[\beta_{cc}(lnc_{it})^2 + \beta_{ll}(lnl_{it})^2 + \beta_{mm}(lnm_{it})^2] + \beta_{cl} lnc_{it}*lnl_{it} + \beta_{cm} lnc_{it}*lnm_{it} + \beta_{lm} lnl_{it}*lnm_{it} + v_{it} - u_{it}$	$\beta_t = \beta_{tt} = \beta_{nt} = 0$
Cobb Douglas with efficiency model.	$lny_{it} = = \beta_0 + \beta_c lnc_{it} + \beta_l lnl_{it} + \beta_m lnm_{it} + v_{it} - u_{it}$	$\beta_t = \beta_{tt} = \beta_{nt} = \beta_{nk} = 0$
Cobb Douglas without efficiency model	$lny_{it} = \beta_0 + \beta_c lnc_{it} + \beta_l lnl_{it} + \beta_m lnm_{it} + v_{it}$	$\gamma = \delta_0 = \delta_j = 0$

Source: Suyanto & Bloch (2009).

The generalized likelihood ratio that is compared by Chi square distribution is employed in order to choose a better functional form for the data,. The likelihood ratio (LR) test is calculated by:

$$LR = 2\left[\log L\left(\hat{\theta}\right) - \log L\left(\tilde{\theta}\right)\right].$$

Where $\left(\hat{\theta}\right)$ is the maximum likelihood estimator of unrestricted and $\left(\tilde{\theta}\right)$ is the restricted model. If the value of LR test is bigger than the χ^2 distributions, the null hypothesis is rejected (Verbeek 2008, p.183).

After estimating the production function, the next step is to estimate the determination of technical inefficiency. The factors that can affect technical inefficiency are examined by estimating:

$$u_{it} = \delta_0 + \delta_1 Ownership_{ijt} + \delta_2 Location_{ijt} + \delta_3 Size_{ijt} + \delta_4 Horz_{ijt} + \delta_5 Fiscal_{ijt} + \omega_{it} \quad (6)$$

Where ω_{it} *is* an error term to measure the random differences across firms.

Definitions of each variable used in this study are represented in Table 3.

Table 3: Definition of variables

Variables	Definitions
Y	Firm's output (rupiah) calculated by the value of goods produced deflated by wholesale price index (WPI) for five-digit ISIC industries at a constant price of 2000
C	Value of capital owned (rupiah) deflated by WPI at a constant price of 2000
L	The number of labor employed per working day (person)
M	Material expenses (million rupiah) deflated by wholesale price index for manufacturing capital goods at a constant price of 2000
t	Time trend
Ownership	Capital ownership status which is represented by dummy variable: 1 if the capital is owned by foreign, and 0 if the capital is owned by domestic and -1 if it is non-facility status
Location	Firm's location measured by dummy variable: 1 if the company is located inside industrial area, and 0 if otherwise
Size	Size of firm in terms of output which is determined by dummy variable: 1 if the value of firm's output is greater than 100 million rupiah, and 0 if otherwise
Horz	Horizontal Spillovers: Impact of foreign equity ownership and the benefits it delivers to local firm in the same market $Horz_{it} = \frac{\sum FS_{it} * Y_{it}}{\sum_i Y_{it}}$ FS is a share of foreign equity in firm *i* at time *t* , Y_{it} represents share of output in firm *i* at time *t,* and $_i Y_{it}$ is total output in the same

	industry (5 digits ISIC)
Fiscal	Dummy variable (1 if firm gets fiscal incentive, 0 otherwise) Type of fiscal incentives: income tax reduction for investment in certain industries and region.

Total Factor Productivity Decomposition

Total factor productivity (TFP) growth can be decomposed by using the Malmquist TFP index. This index can be calculated by two approaches; derivative-based techniques and explicit distance measures (Coelli et al. 2005). In this study, derivative-based techniques are applied. According to these techniques, the components of TFP growth are rate of technological change (TP), scale component (SC) and a change in technical efficiency (TE). Technological change is a partial derivative of the production function with respect to the time, the elasticity contribution to the TFP growth is defined as scale component. In this study, following Kumbhakar and Lovell (2003), from the estimated translog model with time varying technical efficiency model, technological progress and scale component can be formulated as:

$$TP = \frac{\partial \ln(y_{it})}{\partial t} = \beta_t + \beta_{tt} t + \beta_{ct} \ln c_{it} + \beta_{lt} \ln l_{it} + \beta_{mt} \ln m_{it} \qquad (7)$$

$$SC = (e-1)\sum_j \left(\frac{e_j}{e}\right)\dot{x}_j \qquad (8)$$

Where e_j is the elasticity of output with respect to input and $\dot{x}_j$ is the growth rate of inputs.

The elasticity of output with respect to each input shows the relative change in output due to change in each input. According to Verbeek (2008, p. 56.), elasticity can be calculated as:

$e_c = \beta_c + \beta_{cc} lnc_{it} + \beta_{cl} lnl_{it} + \beta_{cm} lnm_{it} + \beta_{ct} t$
$e_l = \beta_l + \beta_{ll} lnl_{it} + \beta_{cl} lnc_{it} + \beta_{lm} lnm_{it} + \beta_{lt} t$
$e_m = \beta_m + \beta_{mm} lnm_{it} + \beta_{cm} lnc_{it} + \beta_{ml} lnm_{it} + \beta_{mt} t$

In this study the elasticity is estimated at the value of input at *i'th* firm in *t* time.

From the technical efficiency resulted from equation (1), following Khalifah et al.(2008, p. 93) the change in technical efficiency can be calculated as:

$$TEC = \frac{TE_{i(t+1)}}{TE_{it}} \qquad (9)$$

From equations 7, 8 and 9, TFP growth can be calculated as $\dot{TFP} = TP + SC + TEC$ (Kumbahkar & Lovell 2003)

After obtaining TFP growth, a panel data regression is employed in order to estimate the determinants of TFP growth. The determinants are similar to that for technical inefficiency determinants, as the latter is an important component of the TFP growth, which is also empirically proved in this study. The linier panel data regression can be explained as:

$$\dot{TFP}_{ijt} = \alpha_0 + \alpha_1 Ownership_{ijt} + \alpha_2 Location_{ijt} + \alpha_3 Size_{ijt} + \alpha_4 Horz_{ijt} + \alpha_5 Fiscal_{ijt} + \chi_{it}$$

5 RESULTS

Finding the functional form

Finding the functional form that can represent the data appropriately is the first step in Stochastic Frontier Analysis. Five types of functional forms in the production function are considered and tested in this study. The unrestricted model tested is the Translog model since it has the most complicated forms in terms of variables. First, we test the Translog against the Hicks-Neutral model to identify which model can represent the data better. The null hypothesis is $\beta_{nt}= 0$. The LR test result is 1157.54 which is bigger than a χ^2 distribution. Therefore, the null hypothesis is rejected. This means that the Translog model is admitted. The next null hypothesis is $\beta_t= \beta_{tt}= 0$. The LR test result is 2743.78 that is bigger than a χ^2 distribution examined at 1 per cent level. This means the alternative hypothesis is failed to rejected so the Translog model fits better than the No-technological progress model.

Based on the log-likelihood ratio test, the Translog production function can represent the data better than the Cobb Douglas model either with or no efficiency component. This is due to LR test is bigger than the Chi square distribution at 1 per cent level. The LR test between the Translog and Cobb Douglas with efficiency is 7733.038 and 9271.352 for the Translog against Cobb Douglas with no efficiency. Since the Translog model is applied in this study, the stochastic effects and technical efficiency are important factors contributing production process. This conclusion is supported by a significant Gamma value in Translog model when tested at 1 per cent level.

Table 4: Test of Functional Form for Stochastic Frontier Analysis

Sub Model	H_0	The LR test	χ^2(1% level)	Conclusion
Hicks Neutral	$\beta_{nt}= 0$	1157.54	11.34	Failed to reject Translog
No-technological progress	$\beta_t= \beta_{tt} =0$	2743.78	15.09	Failed to reject Translog
Cobb-Douglas with efficiency	$\beta_t= \beta_{tt} = \beta_{nn} = \beta_{nk} =0$	7733.038	24.73	Failed to reject Translog
Cobb Douglas No efficiency	$\gamma =\delta_0 = \delta_j = 0$	9271.352	32.0	Failed to reject Translog
Conclusion: Translog model is failed to be rejected to represent the data				

Source: Author's calculation from the log likelihood ratio.

Stochastic frontier analysis results

The results of the Translog model estimation demonstrate that the parameter of capital is positive and significant when tested at 1 per cent level. This result confirms that if the number of capital raise, the firm's output in the three sectors will increase. On the other hand, the coefficient of capital squared is negatively significant at 1 per cent level. These result shows a diminishing return to capital in the three manufacturing sectors. This means that when a firm adds their capital input, the output will increase but at some points, the marginal of increase in the capital will reduce. Whereas, the estimation of two other inputs, labor and material, the diminishing return law did not occur. The parameters of labor and material are positive and significant when tested at 1 per cent level. Similarly, the coefficients estimated at squared level of those inputs are also positive and statistically significant. This means that a diminishing return law does not hold in labor and material inputs.

Furthermore, the cross effect of the inputs can be examined through the estimated coefficient for interacting input variables. If the second order for cross-effects of the inputs is positive the inputs of production have a substitution effect. In contrast, if the cross-effect is negative, the inputs give a complementary effect (Ogundari & Brummer 2011 p. 67). First, the coefficient of the interaction variables between labor and capital is positive and significant when tested at 1 per cent level. Therefore, labor and capital have a substitution effect in the three manufacturing sectors. In contrast, the parameters estimated for the other interacting variables are negative and statistically significant at 1 per cent. This means either labor-material or material-capital have a complementary effect. For the times variable, the level and squared times have a different result. The coefficient of the time variable is significantly positive meaning that time as the technological progress indicator, has a positive relationship with output. In contrast, the parameter estimated for time squared is negative statistically significant. This suggests that the effect of time on output will fall at some point.

In addition, the interaction between the input and time variables is also important. The parameter showing the interaction between capital and time is positive and highly significant. This means that capital exhibited a non-neutral technological progress. This result is also similar to the labor-time coefficient. In contrast, material exhibits technological regress in the sample's production function since the parameter of material-time variable is negatively significant. The result for the production function estimation is presented in the Appendix Panel A.

As the translog production coefficients can not be directly interpreted with economic meaning, it is useful to calculate production efficiencies to observe the effect of input changes on output changes. Elasticity of output with respect to inputs can be used to evaluate the change of output when the level of input is altered. The Total elasticity (etot) for all sectors implies that all sectors experienced a decreasing return to scale in production function. Furthermore, by comparing the value of elasticity of each input, it can be seen that outputs of the three biggest manufacturing sectors in Indonesia are most driven by material input. This is due to more than 50 per cent component of elasticity were contributed most by elasticity of material input. In contrast, the role of capital and input changes affected differently on individual sector's output. In the food manufacturing sector, the change of labor and capital contributed approximately in the same level on output changes. Furthermore, the change in capital had a bigger effect than labor input changes on output in the textile sectors. On the other hand, in the garment industry, the output changes were contributed more by labor change than capital changes. The estimation of output elasticity during the year observation is reported in Table 6.

Table 5: Estimation of elasticity of output with respect to input production

Sectors	Year	ec	el	em	etot
All sectors	2007	0.11	0.06	0.62	0.79
	2008	0.12	0.15	0.55	0.83
	2009	0.13	0.26	0.48	0.87
	2010	0.15	0.33	0.41	0.90
	2011	0.16	0.42	0.35	0.93
	2012	0.17	0.52	0.28	0.97
Food & Beverages	2007	0.10	0.07	0.64	0.81
	2008	0.12	0.15	0.58	0.84
	2009	0.13	0.25	0.50	0.88
	2010	0.14	0.33	0.44	0.91
	2011	0.15	0.41	0.37	0.94
	2012	0.17	0.51	0.30	0.98
Textiles	2007	0.12	0.10	0.58	0.80
	2008	0.14	0.12	0.51	0.76
	2009	0.15	0.22	0.43	0.80
	2010	0.16	0.30	0.37	0.83
	2011	0.17	0.38	0.31	0.86
	2012	0.18	0.48	0.23	0.90
Garments	2007	0.11	0.13	0.58	0.82
	2008	0.13	0.22	0.51	0.86
	2009	0.14	0.33	0.43	0.90
	2010	0.15	0.42	0.37	0.94
	2011	0.16	0.52	0.29	0.98
	2012	0.18	0.51	0.23	0.91

Source: Author's calculation.

Next, the frontier estimation facilitates us to examine the technical efficiencies of the selected manufacturing sectors. It is apparent that all sectors' technical efficiency declined from 0.83 in 2007 to 0.82 in 2012. The biggest decline of technical efficiency occurred in 2008 when the global financial crisis came to surface. Therefore, it can be implied that global financial crisis hit the manufacturing subsectors' efficiency especially the textiles and garments sector which are export-oriented sectors. During the global financial crisis, demand for output of this sector declined particularly from the US and EU countries (Alcorta & Nixson 2010). Furthermore, the trend of technical efficiency is different among the individual sectors. To illustrate, in the food-manufacturing sector, the value of technical efficiency tended to be more stable than others, at around 0.83 in the period. In contrast, the value of technical efficiency in the garment sector was more volatile between 2007 and 2012. The lowest mean of technical efficiency in this sector was 0.825 in 2009 and the highest was 0.84, which is higher than the average of all sectors' efficiency, in 2010. In addition, the textile sector had a downward trend in technical efficiency in the study period. Its value dropped from 0.835 in 2007 to 0.82 in 2012.

The determination of technical inefficiency is another concern in this study. The parameter of the dummy variable for ownership is negatively significant at 1 per cent level. This shows that foreign capital ownership status has a positive effect on technical efficiency. In other words, if the firm has foreign capital ownership status it will obtain higher efficiency than domestic and non-facility status. This result supports some previous studies. For example, Suyanto and Bloch (2009, p. 168) find that foreign-owned firms was more efficient than locally owned firms in the Indonesia'd chemical and pharmaceutical industries. It is due to the better knowledge and technology than locally-owned firms.

Moreover, the location of a company has a positive relationship with technical efficiency. This can be seen from a negative and significant coefficient of the dummy variable for location. This indicates that when a firm is located inside the industrial area, technical efficiency is higher than firm located outside industrial area. Another variable that has a negative effect in technical inefficiency is size of firm. The coefficient estimated of the dummy variable for firm's size is highly negative and statistically significant. This implies that if a company has bigger size in terms of output produced, higher technical efficiency will be obtained.

On the other hand, horizontal linkages and fiscal incentives have a negative effect on firm's technical efficiency. The parameters estimated for the horizontal linkages indicator and dummy variable for fiscal incentives are positive and significant when tested at 1 per cent. This implies that the presence of a foreign firm could not boost the local firms' technical efficiency. Similarly, the fiscal incentives granted by the Indonesian government failed to increase technical efficiency of firms in the three biggest manufacturing sectors. The result of the inefficiency model is presented in Appendix panel B.

As technical efficiency change is an important component of the TFP growth, it will be interesting to see the status of other components in contributing to the TFP growth. Accordingly, after obtaining the technical efficiency estimation from the Stochastic Frontier Analysis, TFP decomposition is the next step that was done in this study. It can bee seen that TFP growth of three manufacturing sectors fluctuated, with a downward trend from 1.11 per cent in 2008 to – 0.15 per cent in 2012. The negative trend of TFP growth also occurred in individual manufacturing sector. The food manufacturing sector generally had a decline TFP along the period. In this sector, only in 2010 TFP grew at positive rate. Similarly, textile-manufacturing sectors also experienced a decrease in TFP growth in the study periods. Meanwhile, garment sectors faced TFP growth during 2008 (0.75 per cent growth) and 2010 (1.68 per cent growth). All samples experienced the highest decline in TFP growth in 2010 when the global financial crisis occured. Furthermore, drawing on the Malmquist's index, the TFP decomposition measurement shows that the decomposition was dominated by the technical efficiency change (TEC). Technological progress (TP) and scale efficiency (SC) contributed negatively to TFP growth. The estimation of total factor productivity growth (TFP), technical efficiency changes (TEC), technical progress (TP) and scale component (SEC) are presented in Table 5.

Table 6: Estimation of Total Factor Productivity (TFP) growth decomposition

	Year	All sectors	Food & Beverages	Textiles	Garments
TEC	2008	1.17	-0.31	-0.34	0.79
	2009	-1.62	-0.12	-0.77	-1.15
	2010	0.52	0.09	0.26	1.72
	2011	-1.70	-0.09	-0.89	-1.42
	2012	-0.07	0.00	-0.06	-0.11
TP	2008	-0.054	-0.062	-0.039	-0.033
	2009	-0.056	-0.064	-0.041	-0.035
	2010	-0.066	-0.075	-0.050	-0.041
	2011	-0.073	-0.082	-0.057	-0.045
	2012	-0.077	-0.086	-0.062	-0.053
SC	2008	-0.0082	-0.0065	-0.016	-0.0052
	2009	-0.0045	-0.0055	-0.0037	-0.0016
	2010	-0.0031	-0.0034	-0.0032	-0.0020
	2011	-0.0027	-0.0027	-0.0038	-0.0013
	2012	-0.0014	-0.0017	-0.0016	-0.00017
TFP	2008	1.11	-0.38	-0.39	0.75
	2009	-1.68	-0.18	-0.82	-1.19
	2010	0.45	0.015	0.21	1.68
	2011	-1.78	-0.18	-0.96	-1.47
	2012	-0.15	-0.084	-0.12	-0.16

Note: Annual rate in per centage
Source: Author's calculation.

Determinants of TFP growth

Using the index of TFP growth which is obtained from the decomposition, the next step is to estimate the sources of TFP growth. As technical efficiency is the major component of the TFP growth in this study, it is rational to argue that the determinants of technical inefficiency and the determinants of the overall TFP growth will be more or less similar. Therefore, the TFP growth is regressed on the same determinants of technical inefficiency in this study. The TFP growth determination was estimated by both the fixed effect (FE) and random effect (RE) model. The Hausman test is implemented to choose which model can represent the data better. Based on the probability for χ^2 distribution of the Hausman test, the fixed effect model better represents the data. Therefore, the best-suited model is used to interpret the estimated parameters for the sources of TFP growth in three biggest manufacturing sector in Indonesia.

The fixed effect model shows that foreign ownership status has a positive and statistically significant relationship with TFP growth when tested at 5 per cent level. This implies that if firm has foreign status, it will achieve higher TFP growth than domestic and non-facility firm. Similarly, the estimated coefficient of the dummy variable for location was positive and significant at 1 per cent level. This means that if company is located inside the industrial location, TFP growth will be higher than firm located outside the industrial area. The firm's size in terms of output also contributed positively to TFP growth. This can be seen from the parameter that is positive and statistically significant at 5 per cent level. This means that, the bigger firm the higher TFP growth will be. On the other hand, horizontal spillovers of FDI and fiscal incentives contributed negatively to the TFP growth of three manufacturing sectors. This suggests that the presence of foreign firms will reduce TFP growth of local firm in the same market. Finally, a reduce tax on income for investment as a fiscal stimulus distributed by the Indonesian government will reduce the TFP growth of food, textiles an garment industries. The results of estimation TFP determinations are represented in table 7.

Table 7: Estimation of the determinants of the TFP growth

Variable	**FE model**			**RE model**		
	Coefficient	**SE**	**t-ratio**	**Coefficient**	**SE**	**t-ratio**
Constant	0.27	0.42	0.64	0.79***	0.29	2.75
Ownership	1.18**	0.52	2.25	1.16***	0.26	4.49
Location	2.87***	0.35	8.20	2.045***	0.3003	6.81
Size	4.51**	0.96	4.72	1.24***	0.49	2.53
Horizontal	-0.00903***	.0025	-3.60	-0.0021*	0.0013	-1.65
Fiscal	-0.65**	0.33	-1.98	-0.75***	0.31	-2.44
Hausman test Prob>chi2 = 0.0000 (FE)						

Source: Author's estimation

6 DISCUSSION

The Stochastic Frontier Analysis shows that on average Indonesia's food and beverages, textiles and garments manufacturing sectors were less efficient in the period 2004-2009 with the means of technical efficiency is approximately 83 per cent. This is higher than the average technical efficiency of Indonesia's weaving firms, which was around 60 per cent to 70 per cent (Pitt & Lee 1981). Dhanani (2000 p.50) argues that the lower efficiency of these three subsector with more labor-intensive nature was due to the lack of efficient industrial technology supports, skilled human resources, centre productivity network and foreign technology adoption. Furthermore, the results show that labor and capital are substitution inputs in the three subsectors. This is similar with the result for garment industries (Hill & Kalirajan 1993).

The technical inefficiency estimation shows that foreign direct investment has a positive relationship with technical efficiency. This result is similar to previous studies. For example, foreign multinational firm in Malaysia's automotive sector were significantly more efficient than locally owned plants during 2000-2004 (Khalifah & Talib 2008). Suyanto et al. (2009) argues that FDI generated positive productivity spillovers in Indonesian chemical pharmaceutical industries from 1988 to 2000. In addition, this result is as expected since FDI can generate technology transfer and human capital development in many developing countries (OECD 2002).

Similarly, location also contributed positively to technical efficiency and productivity growth in three biggest manufacturing subsectors. This result is as expected since industrial areas can bring a positive affect on the firms' performance. This is due to when firms are located inside the industrial areas, they gain more benefit such as lower transportation cost in the input market, lower cost of research and development program and also the supply of well-developed public infrastructure (Syahruddin 2010)

Size also contributed positively to technical efficiency and productivity growth. The bigger size of firm, the higher technical efficiency and TFP growth will be. This result is similar to some prevoius studies. To illustrate, Diaz and Sanchez (2008) argue that small firms were less efficient than medium-size firms in Spain from 1995-2001 Furthermore, Margono and Sharma (2006) argue that size contributed positively to technical efficiency of metal products industries in Indonesia from 1993 to 2000. In adition, Prabowo and Cabanda (2011) observing all Indonesia's manufacturing sector from 2000 to 2005 find firm's size had a positive relationship with technical efficiency. Finally, the positive contribution of firms' size to TFP growth is identical with some pervious studies arguing that a bigger firm tends to have higher productivity growth (for example, Javorchick et al. 2012; Mangistae 1998; Biesbroeck 2005; Leung et al. 2008)

In contrast, horizontal spillovers have a negative effect on technical efficiency and productivity growth of food and beverages, textiles and garments sectors. This is similar to the effect of horizontal spillovers on Indonesia's pharmaceutical sector (Suyanto & Salim 2011). Aitken and Harrison (1999) argued that a negative effect of horizontal spillovers is due to the market-stealing phenomenon. This is because the foreign firms, which have more competitive advantages than the domestic firm market, reduce the market share of locally-owned firms in the same market. Consequently, domestic's firm performance will decline. Lastly, TFP growth in the three biggest subsectors averagely was between -1.78 per cent and 1.11 per cent along the study period. This result is different from the result obtained by some previous studies (Timmer 1999, p. 90; Aswicahyono & Hill 2002, p. 158; Modjo 2006).

7 CONCLUSION

Stochastic Frontier Analysis was implemented in this study to estimate technical efficiency in Indonesia's food and beverages, textiles and garments manufacturing sectors from 2004 to 2009. The result reveals that these industries are not fully technical efficient with a mean average technical efficiency of 83 per cent. The results also indicate that characteristics of firms such as foreign-owned status, location and firm' size in terms of output value have a positive and significant effect on technical efficiency and productivity. Whereas, horizontal spillovers and fiscal incentives contributed negatively to technical efficiency and TFP growth.

In addition, the TFP decomposition approach reveals that during the study period average TFP growth of the three biggest subsectors was volatile. The decomposition of TFP growth was dominated by technical efficiency change. Moreover, the elasticity of output with respect to material was higher than the elasticity of output with respect to capital and labor. This indicates that these sectors were highly dependent on material input. Total elasticity in this type of production was less than 1 which mean that these industries exhibited decreasing returns to scale production function.

This study revealed that foreign direct investment (FDI), industrial area and firm's size in terms of output have a positive correlation with technical efficiency. This means FDI inflow should be raised in Indonesia's manufacturing sectors. However, the tax reduction on income for investment may decrease efficiency and productivity growth. Therefore, the Indonesian Government could try another scheme to attract more FDI. This could be done by implementing new fiscal policy such as a tax holiday. Recently, Indonesia's government implemented tax holiday for approved projects in some industrial sector such as metal-based industry, chemical and pharmaceutical sector, iron and steel, and crude oil refining industry (UNCTAD 2000, see United Nations Conference on Trade and Development). It has not been implemented to food and beverages, garments and textile sectors. Hence, government could implement tax holiday for approved projects in these sectors. Moreover, according to the results, industrial area could increase technical efficiency and productivity growth. Hence, Indonesia's government should develop more industrial areas since the number of industrial areas is still limited (Syahruddin 2010).

This study had one limitation. This study only examined technical efficiency. Allocative efficiency, which is another component of economic efficiency, could not be estimated due the limitation of data on firm's cost and price. Hence, in the future estimation of the allocative efficiency needs to be considered.

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APPENDIX A

Production Function	Parameters	CD No Inefficiency	CD With Efficiency	No Technical	Hicks	Translog
Constant	β0	2.58 *** (0.053)	2.68 *** (0.18)	6.37 *** (0.14)	8.562 *** (0.19)	9.739 *** (0.27)
Ln(Capital)	β1	0.04 *** (0.0034)	0.07 *** (0.0039)	0.14 *** (0.013)	0.011 - (0.013)	0.044 *** (0.017)
Ln(Labour)	β2	0.38 *** (0.0042)	0.35 *** (0.004)	1.22 *** (0.052)	1.305 *** (0.051)	1.364 *** (0.052)
Ln(Material)	β3	0.71 *** (0.0023)	0.68 *** (0.0066)	-0.09 *** (0.019)	-0.208 *** (0.024)	0.438 *** (0.029)
Trend	β4	-	-	-	-0.030 *** (0.0087)	0.170 *** (0.028)
[Ln(Capital)]^2	β5	-	-	0.00 ** (0.00034)	-0.002 *** (0.00044)	-0.001 *** (0.00047)
[Ln(labour)]^2	β6	-	-	0.04 *** (0.0031)	0.049 *** (0.0031)	0.066 *** (0.0031)
[Ln(Material)]^2	β7	-	-	0.05 *** (0.00081)	0.051 *** (0.00081)	0.067 *** (0.00079)
Trend^2	β8	-	-	-	-0.006 *** (0.0012)	-0.002 *** (0.0012)
Ln(capital)*Ln(Labour)	β9	-	-	0.04 *** (0.0033)	0.031 *** (0.0033)	0.029 *** (0.0033)
Ln(capital)*Ln(Material)	β10	-	-	-0.02 *** (0.0013)	-0.006 *** (0.0015)	-0.004 *** (0.0019)
Ln(Labour)*Ln(Material)	β11	-	-	-0.12 *** (0.0027)	-0.125 *** (0.0028)	-0.148 *** (0.0028)
Ln(capital)*Trend	β12	-	-	-	-	0.007 *** (0.0017)
Ln(Labour)*Trend	β13	-	-	-	-	0.052 *** (0.0021)
Ln(Material)*Trend	β14	-	-	-	-	-0.038 *** (0.0012)

Notes: CD is Cobb-Douglas; ** significant at 5% level; *** significant at 1 % level

APPENDIXB

Ineffciency Model	Parameters	CD No Inefficiency	CD With Efficiency	No Technical	Hicks	Translog
Constant	δ0	-	0.07 ***	0.07 ***	0.373 ***	-4.498 ***
			(0.022)	(0.025)	(0.017)	(0.20)
Ownership	δ1	-	-0.23 ***	-0.35 ***	-0.181 ***	-0.737 ***
			(0.0079)	(0.017)	(0.011)	(0.018)
Location	δ2	-	-0.19 ***	-0.401 ***	-0.068 ***	-1.141 ***
			(0.0058)	(0.020)	(0.011)	(0.041)
Size	δ3	-	-0.19 ***	-1.077 ***	-1.614 ***	-1.975 ***
			(0.058)	(0.071)	(0.042)	(0.064)
Horizontal	δ4	-	0.00 ***	0.000 -	0.000 **	0.000 ***
			(0.000054)	(0.0000062)	(0.000004)	(0.000028)
Fiscal	δ5	-	-0.09 ***	-0.06 ***	-0.058 ***	0.047 ***
			(0.023)	(0.016)	(0.0094)	(0.011)
Gamma	γ	-	0.00 ***	0.18 ***	0.148 ***	0.848 ***
			(0.0000026)	(0.0089)	(0.004)	(0.0066)
Log Likelihood		-21785.22	-21016.07	-18521.44	-17728.32	-17149.55

Notes: CD is Cobb-Douglas; ** significant at 5% level; *** significant at 1 % level