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Super Slack-Based Model Efficiency And Stock Performance Of Manufacturing Industry Listed In Indonesian Stock Exchange

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Abstract

This research examines the efficiency of Indonesian manufacturing industry listed in the Indonesian Stock Exchange during the period of 2010-2014 using non-parametric output oriented Super Slack-Based Model (SBM). 77 companies in manufacturing industry classified as basic, miscellaneous and consumer goods industry listed in the Indonesian Stock Exchange during 2010-2014 which resulted in 308 pooled data is being analyzed. The result shows that on average the highest output oriented Super SBM efficiency is a miscellaneous industry while basic and consumer goods industry are not efficient on average.

Keywords: Efficiency; Indonesia Stock Exchange; manufacturing industry; stock performance; Super Slack-Based Model.

1. Introduction

   The manufacturing sector is becoming the imperative factor in East Asia (Liao et al, 2007) and frequently discussed in the research papers. As Nehru (2013) pointed out that manufacturing create needs for inputs and corresponding outputs from other sectors (ie. agriculture and service) that lead to economic growth and employment. For Indonesia, manufacturing sector also plays a crucial role as can be proven by the facts that, the government of Indonesia has

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already prepared some crucial moves such as strengthening the industry structure and escalating the industry environment in welcoming Asian Economic Community (AEC) 2015. Those are including cutting back cost of capital, energy and logistic. Not to mention to enlarge research and development as well as to improve the labors capability in the manufacturing sector (Bank Indonesia, 2014).

In the last 3 years, Indonesian economy has experienced a sluggish growth from 6.03% in 2012, 5.58% in 2013 and 5.02% in the year of 2014. This condition is triggered by the declining of export growth, in particular the natural resource commodities (Bank Indonesia, 2014). However, manufacturing industry is contributing steadily to GDP in the last 3 years, from 21.46% in 2012, 20.98% in 2013 and it is slightly going up to 21.02% in 2014 and it is indeed the foremost contributor compared to other sectors (BPS Report, Feb 2015). From 2009-2013 there are 71.3 million people that worked in manufacturing industry, primarily in the industry of food and beverage and industry of tobacco for 28% (Bank Indonesia, 2014). Besides farming, trading sector and service industry, manufacturing is the biggest industry that employs labors (15.26% per August 2014, BPS Feb 2015).

Most of the previous researches have been seeking to know how efficient the manufacturing sector were and this research being extended to measure not only efficiency but also the relationship with the stock returns together with other factors as they have significant implications to decision makers in the organizations such as shareholders, managers and investors. Numerous studies are conducted on measuring efficiency or productivity using DEA in various industries worldwide such as banking industry (Galagedera and Edirisuriya, 2004), garment industry (Joshi and Singh, 2010), international airports (Yang, 2010), manufacturing industry (Chang and Wu, 2007; Liu and Wang, 2008), agriculture industry (Selamat and Nasir, 2013), retailers (Gandhi and Shankar, 2014).

Prior to date, there are many researches have been conducted to examine the efficiency or productivity of manufacturing firms in Indonesia. Using stochastic frontier model (parametric approach), Margono and Sharma (2006) studied Indonesian manufacturing industry from 1993-2000 and founded the decreasing rate of productivity in most of industries except chemical sector. Using the same method, Mojo (2007) analyzed the magnitudes of productivity growth and technical efficiency changes of Indonesian manufacturing industry from 1998-2000 to consider the effect after the economic crisis in 1997 and resulted that yearly average of technical efficiency went down by 1.47% although some industries experienced an increase. Besides, the productivity growth per year was 2.87% during the period and it triggered by technical progress that contributed 3.98% in average. Prabowo and Cabanda (2011) studied of Indonesian firms' efficiency listed in Indonesia Stock Exchange (IDX) during the year of 2000-2005 using stochastic frontier approach. In addition, Viverita and Ariff (2008) used Malmquist DEA to measure the productivity of state and non-state firms during the period of 1992-2001 and found that there is a productivity decline in these sectors that caused by technological regressions.

The aforementioned papers that use standard DEA assume that reduction of unfavorable inputs (outputs) is balanced with the increase of favorable outputs, thus it is implicating the efficiency scores estimation disregard the inputs and output slacks (Liu, 2009) and further, the scores resulted may not fully revealed the facts in the slacks. This paper differs from previous works that studied about manufacturing industry in Indonesia for it employs a DEA model that takes account the input and output slacks that represent the input excesses and output shortfalls (Tone, 2001), called Slack Based Model (SBM). Liu and Wang (2007) also mentioned the significance of examining the efficiency ratio and also the slacks as they can refer to different result or solution. Not only limited to that, this study also applies another approach by Tone (2002) that is Super SBM, to rank the efficient DMUs.

There have been several researches that applied the Super SBM (Tone 2001, 2002) to measure firms' performances such as Duzakin and Duzakin (2007) that analyzed the performance of 500 major manufacturing firms in Turkey during the year of 2003. Both overall firms and specific industries were being examined resulted in 9 firms was efficiently performed and firms were ranked within each industry, given a total of 65 firms was operating efficiently. Further, the analysis showed which inputs and outputs directed to inefficiency together with the degree of surpluses and losses. Using the same method combined with Malmquist Index, Hadad et al (2008) studies the productivity change of Indonesian banks over the period of January 2006 to July 2007. Under the intermediation approach to efficiency estimation, the average of bank efficiency was rationally firm, given the scores between 70% and 82% and leaded to 92 out of 130 banks have efficiencies above 70%. In addition, Liu (2009) applied SBM approach to estimate the performances of 24 commercial banks in Taiwan and concluded that the method was able to predict the efficiency scores and discover some operational matters of the banks in advance. Furthermore, Lozano and Guierrez (2011) also utilized the same approach to measure the efficiency of 39 airports in Spain for the period of 2006-2007, while Bi et

al. (2014) was used input-oriented SBM approach to calculate China's energy and environmental efficiency of power generation sectors that leads to supplementary information about energy usage and environmental protection.

The next stage in this research is to find the relationship between the efficiency and some other control variables to stock return. By measuring the performance of the firms, it could be seen whether efficient firms perform differently in comparison with inefficient firms towards a stock return and other variables selected. Various and very large amounts of researches in the past have been done to seek the relationship between the efficiency of the firms and the stock returns, particularly in the banking sector as Beccalli, Casu and Girardone (2006), Liadaki and Gaganis (2010) in European Union, Ioannidis, Molyneux and Pasiouras (2008) in Asia and Latin America, Hadad et al. (2008) in Indonesia, Gue and Yue (2011) in China and Vardar (2013) in transition countries.

Some closely related research for this study is the work by Frijns, Margaritis, and Psillaki (2012) that employed DEA analysis to calculate the efficiency of the firms based on several combination of inputs and outputs variables in US publicly listed firms during 1988-2007 and perform cross-sectional regressions and found that there is indeed relationship between firm efficiency and stock returns. Gaganis, Hasan and Pasiouras (2013) examined whether stock returns of listed insurance firms has relationship with the cost and profit efficiency in 52 countries during 2002-2008 period and the result is profit efficiency alone affected stock returns.

1. Methodology

2.1 Super Efficiency

DEA is a non-parametric linear programming method that introduced by Charnes, Cooper and Rhodes (1978) or CCR model to measure relative efficiency of decision-making units (DMUs) that are employing multiple inputs to produce multiple outputs. The DEA's objective is to build the efficient frontier (efficient) units (score of 1) by enveloping those DMUs with minimum input level for giving output levels and otherwise. Whereas the inefficient unit will be having score less than 1. There are two types of DEA, radial and non-radial model. The radial model means the changes between input and output will be proportional and efficiency value will be calculated without concerning the slack for both CCR models (Charnes et al., 1978) or later DEA model by Banker, Charnes, and Cooper or BCC model (1984). On the other hand, non-radial model means the changes of input and output will be at dissimilar level and slack will be take into account. Fare and Lovell (1978) developed the non-radial model at the beginning (Tone, 2001).

Slack-Based Model (SBM) was introduced by Tone (2001), is a non-radial DEA model which is calculating the efficiency score ponder the account input and output slacks and giving result between zero and 1, the same with the radial model (Charnes et al., 1978). This model is not the same with the Additive model by Charnes et al. (1985) that also emphasize on dealing with the excesses of input and the shortfalls of the output but there is no scalar measurement. Then, it is leading to no profundity assessment related to inefficiency even though this model is able to differentiate between efficient and inefficient DMU (Liu and Wang, 2008). The most important attributes of SBM by Tone (2001) are invariant respective to the measurement units and monotone decreasing in each input and output slack. There is $j=1,…., n$ DMU with X_{ij} represents multiple inputs ($i=1,….m$) and Y_{rj} ($r=1,….s$) represents multiple outputs of DMUj. While s_i^- and s_r^+ as the slack variables for ith input and rth output, λ_j represents the weight of DMUj during the performance measurement of DMU_0. Then SBM model will be as follows, to evaluate of DMU_0 under the assumption of constant returns to scale (Tone, 2001):

$$\min\ \rho = \frac{1-\frac{1}{m}\sum_{i=1}^{m} s_i^-/x_{i0}}{1+\frac{1}{s}\sum_{r=1}^{s} s_r^+/y_{r0}}\quad subject\ to\ x_0 = X\lambda + s^-\ ,\ y_0 = Y\lambda - s^+$$

$$\lambda \geq 0, s^- \geq 0, s^+ \geq 0 \tag{1}$$

The model assumed that $X \geq 0$, if $x_{i0} = 0$, then the term s_i^-/x_{i0} is being removed from the objective function. If the optimal solution for SBM is ($\rho^*, \lambda^*, s^{-*}$ and s^{+*}) then DMU_0 (x_0, y_0) is SBM efficient if $\rho *= 1$ which is corresponding with $s^{-*} = 0$ and $s^{+*} = 0$, as no slack variables for input (input excess) and no slack variables for output (output shortfall) in an optimal solution. It is providing an efficiency score between 0 and 1.

The best DMU will have the efficiency of unity and the rank of these efficient units cannot be differentiated between themselves. At first, Andersen and Peterson (1983) had developed super efficiency for both CCR and extension of CRR or BCC model to provide the ranks or differentiate the efficient units (in Zhu, 2009). However the data of efficient DMU_0 is being eliminated from the solution set (Cooper, Seiford and Tone, 2007). Therefore Tone (2002) developed Super SBM model to improve and assume DMU_0 is SBM efficient, $p^* = 1$, Super SBM will be as:

$$\min \delta = \frac{\frac{1}{m}\sum_{i=1}^{m} \overline{x_i}/x_{i0}}{\frac{1}{s}\sum_{r=1}^{s} \overline{y_r}/y_{r0}} \quad subject\ to\ \bar{x} \geq \sum_{j=1,\neq 0}^{n} \lambda_j x_j\ ,\ \overline{y} \leq \sum_{j=1,\neq 0}^{n} \lambda_j y_j$$
$$\bar{x} \geq x_0\ and\ \overline{y} \leq y_0,\ \overline{y} \geq 0,\ \lambda \geq 0 \tag{2}$$

Dealing with the negative outputs in the efficiency calculation of SBM is a crucial matter needs to be considered. As being introduced in DEA Solver Pro 4.1 (Cooper, Seiford and Tone, 2004), a new arrangement was introduced as follows:

$$if\ y_{r0} \leq 0,\ then \begin{cases} \bar{y}_r^+ = \max_{j=1,...,n} \{y_{rj}|\ y_{rj} > 0\} \\ \underline{y}_r^+ = \min_{j=1,...,n} \{y_{rj}|y_{rj} > 0\} \end{cases} \tag{3}$$

if the output r has no positive components, then it is defined as $\bar{y}_r^+ = \underline{y}_r^+ = 1$. It is replaced s_r^+/y_{r0} in the objective function as following way:

$$\begin{cases} if\ \bar{y}_r^+ > \underline{y}_r^+,\ it\ is\ replaced\ by\ s_r^+ \Big/ \dfrac{\underline{y}_r^+(\bar{y}_r^+ - \underline{y}_r^+)}{\bar{y}_r^+ - y_{r0}} \\[3ex] if\ \bar{y}_r^+ = \underline{y}_r^+,\ it\ is\ replaced\ by\ s_r^+ \Big/ \dfrac{(\underline{y}_r^+)^2}{B(\bar{y}_r^+ - y_{r0})} \end{cases} \tag{4}$$

where B = is large positive number

The preferred objective of the SBM model in this research is to maximize the output (output oriented) with the current amount of observed inputs. The same reason as in Duzakin and Duzakin (2007) that one of the input variables which is an amount of salaries, wages and benefit related to the labor force and to minimize it will lead to severe social consequences. Tone (2002) developed output oriented Super SBM as follows:

$$\min \delta = \frac{1}{\frac{1}{s}\sum_{r=1}^{s} \overline{y_r}/y_{r0}} \quad subject\ to\ \bar{x} \geq \sum_{j=1,\neq 0}^{n} \lambda_j x_j\ ,\ \overline{y} \leq \sum_{j=1,\neq 0}^{n} \lambda_j y_j$$
$$\bar{x} = x_0\ and\ 0 \leq \overline{y} \leq y_0,\ \lambda \geq 0 \tag{5}$$

2.2 Panel Regression

Stock performance is calculated on the basis of monthly returns using the cumulative annual stock returns (CASR) in the following formula:

CASR in year t = ((1+month1 return)*(1+month2 return)* . . . * (1+month12 return)) – 1 (6)

To evaluate the relationship between stock return performance and the efficiency, cumulative annual stock returns (CASR) is being regressed to changes in the efficiency and several corporate control variables, annual change in total asset to control size and annual change in total equity to total assets ratio to control the risk or solvency ratio (Liadaki and Gaganis, 2010; Gue and Yue, 2011; Gaganis, Hasan and Pasiouras, 2013; Vardar, 2013) of the corporation. Changes in the efficiency are in favor based on the fact that investors who would make investment in manufacturing sector industry will able to obtain the information about the change of firm efficiency between the year t and year t-1, instead of year t (Vardar, 2013). The regression model is estimated:

$$CASR_{i,t} = \alpha + \beta_1\ CHGEFF_{i,t} + \beta_2\ CHGASSET_{i,t} + \beta_3 CHGRISK_{i,t} + \beta_{4-7}YearDummies + \varepsilon_{i,t} \tag{7}$$

Where for corporate i, time t: $CASR_{i,t}$ is a cumulative annual stock return, $CHGEFF_{i,t}$ denotes efficiency change, $CHGASSET_{i,t}$ is the annual change in total asset and $CHGRISK_{i,t}$ is the annual change in total equity to total assets ratio, α is an overall constant in the model, β_j (j=1,2,3,4…7) represents slope parameters, $\varepsilon_{i,t}$ denotes the error terms and year dummy variables are also included in the model to measure the potential time effects in the stock returns.

Since using OLS regression is making the result biased as the difficulty to meet the assumption of independence and homocedasticity of the errors terms in the panel data as the corporations' observations within themselves is likely to

be correlated. Then the panel regression is being used and as generally written in the previous literatures (Baltagi, 2013; Liadaki and Gaganis, 2010, Gaganis, Hasan and Pasiouras, 2013; Vardar, 2013) about the selection of fixed effects (FE) and random effect (RE), several tests are conducted as Breusche-Pagan Lagrange Multiplier (LM) and Hausman's test. Besides, in controlling cross-section heterocedasticity that would affect the result, White's transformation with corrected degree of freedom is employed in the model.

2. Data and Variables

There are 77 manufacturing companies' data taken from the year of 2010-2014, a total of 308 data that is representing a balanced panel data. The companies have taken as a sample must be publicly listed before the year of 2010 to acquire representative evaluation. Annual Reports, Financial Statements of the companies and monthly stock prices of companies in the samples are collected from Indonesia Stock Exchange (IDX) and corporations' website.

The selection of the inputs and outputs variable being used in DEA studies always be a foremost matter since it can lead to misleading conclusions (Duzakin and Duzakin, 2007). Many of previous research are using sales or net sales as their output, but Duzakin and Duzakin (2007) showed that a company that achieves high amount of sales but failed to meet a satisfactory profit margin will lead to misleading company's performance. Therefore this study is using salary, wages and benefits to represent labor cost; net fixed assets; material used cost as the input variables and earning or profit before tax as the output variable.

For the regression, as explained in 2.2., the dependent variable is stock performance calculated using the cumulative annual stock returns (CASR) while the independent variables are changes in the efficiency, annual change in total asset to control for size and annual change in total equity to total assets ratio to control for risk or solvency ratio.

3. Results and Analysis

4.1 Result of Super Efficiency

As presented in Table 1, the result of SBM Efficiency and Super SBM Efficiency overall mean for 308 firms in the manufacturing sector during the period of 2010-2014 is 0.3702 and 0.9465. The result of Super SBM is higher due to some firms are having a higher efficiency score ($\geq$1) in the condition of having efficient SBM (=1) based on the approach by Tone (2002) as the way to differentiate between efficient firms. SBM result indicates that manufacturing sector industry in Indonesia is far from being efficient and numerous actions required for principal development. It is confirmed that the firms in the sample should improve the profit by approximately 63%. The averages of SBM efficiency for manufacturing industry category (basic, miscellaneous and consumer goods) are 0.2996, 0.4619 and 0.4233. Whereas the result of Super SBM shows the efficiency score of 0.4154, 1.4723 and 0.5477. The same result shown by Prabowo and Cabanda (2011) that miscellaneous sector is having the highest efficiency.

Looking at the yearly result, it shows that the average of SBM efficiency across all firms is experiencing a downward trend from 0.4226 in 2010 and reaching 0.3298 in 2013 before it is slightly moving up to 0.3350 in 2014. While Super SBM efficiency result is having upward trend from the year 2010 (0.6626) to 2011 (0.8672) before declining over the next period and attained the score of 0.4206 in 2014. The difference of Super SBM and SBM result for year 2010 to 2011 could be understood since during the year of 2011 the score of Super SBM efficiency for some efficient firms are way higher compared to the previous year though it is not adding the number of efficient firms (as seen in Table 2).

This result is supported by the data of percentage of efficient firms (Table 2) as a whole from 4.55% in the beginning of analysis period 2010 to merely as much as 2.6% in the last year of the period. That means among 77 firms, simply 8 of them are efficient and there are 4 companies consistently efficient for the whole period. They are INTP (basic), ASII (miscellaneous), HMSP and UNVR (consumer goods). Firms in miscellaneous manufacturing sector have the highest efficient firms from year to year.

Table 1. Result of SBM and Super SBM Efficiency

Averages by year		SBM Efficiency	Super SBM Efficiency
2010	N = 77	0,4226	0,6626
2011	N = 77	0,3920	0,8672
2012	N = 77	0,3715	0,8444
2013	N = 77	0,3298	0,7470
2014	N = 77	0,3350	0,4206
Averages by manufacturing category			
Basic	N = 39	0,2996	0,4145
Miscellaneous	N = 19	0,4619	1,4723
Consumer Goods	N = 19	0,4233	0,5477
Total Sample			
Total Sample (N = 308)		0,3702	0,9465

Table 2. Percentage of Efficient Firms

Year	Basic	Miscellaneous	Consumer Goods	All
2010	17.95%	26.32%	10.53%	4.55%
2011	12.82%	21.05%	10.53%	3.57%
2012	10.26%	26.32%	10.53%	3.57%
2013	7.69%	21.05%	10.53%	2.92%
2014	10.26%	10.53%	10.53%	2.60%

Furthermore, as mentioned previously that besides the ratio or efficiency, the emphasis on the slack (input excess or output shortfalls) is becoming significant factors that need to be focused with. In this study output oriented model is being used that has purpose to seek the output shortfalls that cause inefficiency without any changes in the input excesses. By observing output shortfalls in figure 1, it is clearly shown that requirement to increase firms' earning or profit before tax is fluctuating during the year of 2010-2014. The trend is going down from 2012 (Rp 419.648 billion) afterwards and needs to add an average of Rp 316.312 billion to be efficient in 2014. Among average of excess input variables, the most constant and also the lowest is indicated by salary, wages and benefit while material used cost is the most varied.
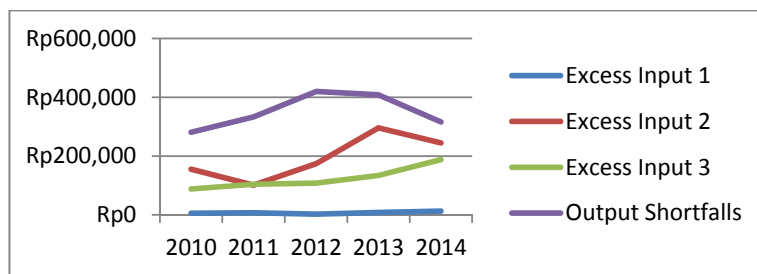

Figure 1. Average of Excess Input and Output Variables (in million Rupiah)

Excess Input 1 = salary, wages and benefit; Excess Input 2 = material used cost; Excess Input 3 = fixed asset, net; Output Shortfalls = earning or profit before tax

In addition, of the perspective of manufacturing category it indicates that the miscellaneous industry requires the least to enlarge earning or profit before tax compared to other category (figure 2) from year to year. Whereas consumer goods industry needs to increase the greatest amount of output shortfalls in order to be efficient. In figure 3 particularly miscellaneous industry is having zero input excess of salary, wages and benefit from the year of 2010-2012 before the excess input is rising up to Rp 4,566.64 million in 2014. Similar pattern also being demonstrated by an input excess

of material used cost (figure 4) that miscellaneous industry is the one gets the least amount and the basic industry has the highest amount of input excess. In other words, miscellaneous industry consists of automotive and components, textile garment, cable and electronics firms are able to perform more efficient in utilizing the input and producing output in comparison with basic and consumer goods industry during the sample period.

On the other hand, the data of input excess in terms of fixed cost, net as shown in figure 5 is disclosing a fluctuated pattern in those 3 categories of manufacturing industry and does not confirm any industry being the lead in the whole period.
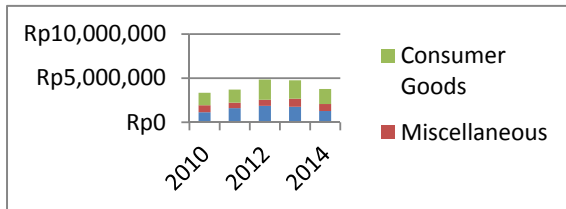

Figure 2. Average of Excess earning or profit before tax (in million Rupiah)
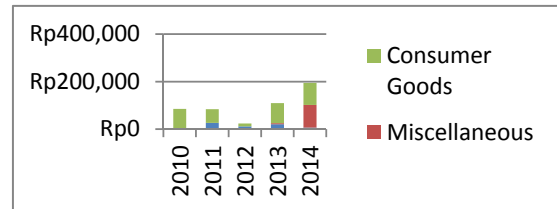

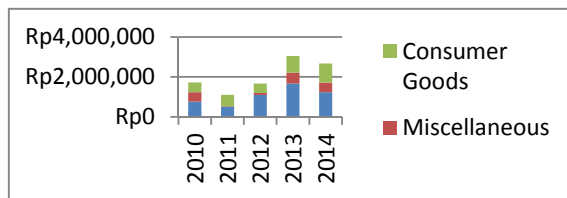Figure 3. Average of Excess salary, wages and benefit (in million Rupiah)

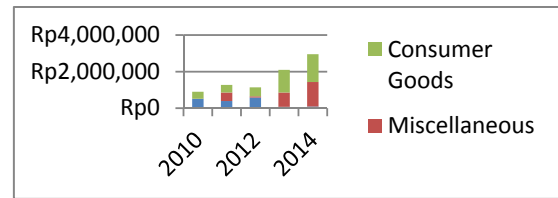Figure 4. Average of Excess material used cost (in million Rupiah)

Figure 5. Average of Excess fixed cost, net (in million Rupiah)

4.3 Result of Panel Regression

The later stage of the discussion is the result of the panel regression to find the relationship between the efficiency, size and solvency ratio to stock returns. Breusche-Pagan Lagrange Multiplier (LM) and Hausman's test are conducted to test whether fixed effect or random effect model should be preferred. The result of Hausman test is random effect model is preferred (Chi-square statistic equal to 1.66 with df =3, statistically not significant at the 5% and 10%) and White transformation is also applied to control cross section heterocedasticity.

Table 3. Panel Regression Results

Dependent Variable : CASR	Coefficient	Standard Errors	
CHGEFF	0.0001	0.0000	*
CHGASSET	0.4681	0.2047	*
CHGRISK	0.0950	0.0411	*
Constant	0.2886	0.0406	*
Year Dummies	YES		
Adjusted R-sq	0.0292		
F-Statistics	48.71**		
Hausman test	1.66		
No of Firms	77		
No of samples	308		

* and ** statistically significant at the 5% and 1%, respectively; CASR: cumulative annual stock return, CHGEFF: change in efficiency, CHGASSET: change in total assets; CHGRISK : change in equity to total assets ratio

The overall result of regression is presented in Table 3 and indicates that change in efficiency is having positive and statistically significance related to stock returns. It is suggested that the investors are concerned with the financial performance of the firms that also designate the future payments of dividends and capital gains (Vardar, 2013). Nichols and Wahlen (2004) also pinpointed the importance of persistent earnings that affects more strongly to stock returns (in Gaganis, Hasan and Pasiouras, 2013). The change of asset and change of risk (equity to total asset) is also positive and statistically significance related to stock returns. These results are consistent with previous studies as in Frijns, Margaritis, and Psillaki (2012) and Gaganis, Hasan and Pasiouras (2013).

4. Conclusions

The manufacturing sector is always being the most discussed in the research papers and for Indonesia, the manufacturing sector is playing a crucial role in developing the future economics in particular and government has developed plans to strengthen the capability of this sector to welcome Asian Economics Community (AEC) in 2015. Past researches that investigate the efficiency of manufacturing sectors had been used various DEA models that is not taking into account the input excesses and output shortfalls or "slack" as they can refer to different solutions. The present study contributes a first attempt at using SBM DEA by Tone (2001) to compute efficiency of 77 companies in three different categories of manufacturing sector for the period of 2010-2014 that considers the slacks and also employ Super SBM by Tone (2002) that can differentiate the efficient firms. Efficiency of the manufacturing sector in average during the sample period shown inefficiency and miscellaneous industry found to have higher efficiency in comparison with the other industry. Moreover, the relationship between efficiency and stock returns is being assessed and the results indicate a positive and statistically significant relationship between the change of efficiency, change of asset, change of risk and cumulative annual stock return.

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