Technical Efficiency of Malaysian Furniture Manufacturing Industry: A Stochastic Frontier Analysis Approach

Hartini Hamdan[1], Mohd Fahmy-Abdullah[2*], Lai Wei Sieng[3]
[1, 2] *Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia*
[3]*Faculty of Economic and Management, Universiti Kebangsaan Malaysia*
[*]*Corresponding author: mohdfahmy@uthm.edu.my*

Abstract- Global competition has been a major issue in furniture manufacturing industry. The wooden furniture is forced to improve their productivity in terms of price and design as it is becoming the sources of competitive advantage in the industry. Most of the previous studies do not take into account in assessing the technical inefficiency factors in order to improvise firm's efficiency. The objective of this research is to measure the technical efficiency (TE) level in furniture manufacturing industry in Malaysia besides analyzing the technical inefficiency factors to improve the firm's efficiency. Data in the firm levels which were obtained from Department of Statistics (DOS) and will be analyzed by using Stochastic Frontier Analysis (SFA). The study has used cross-sectional data of 710 firms acquired from DOS. The results of the study reveal that the average level of technical efficiency is high. The estimated result identifies the important determinants of technical inefficiency which are due to employee wage rates. The fundamental implication of this study is that furniture manufacturing firms need to boost motivation among employees and strengthen the network of the production market via wage increment.

Keywords— *Technical Efficiency, Technical Inefficiency, Furniture, Firms, Stochastic Frontier Analysis*

1. Introduction

Efficiency is the effective use of inputs effectively Technical Efficiency (TE) is a possible point in the commodity space which is known as efficient point whenever an increase in one of its coordinates (the net output of one kind) can be obtained only at the expense of decline in some other coordinates (the net output of other kind) [1], [2] stated that technical efficiency is the competency of the firm to produce a maximum output when the set of inputs is given.

Malaysia's wood-based subsector has become one of the most important subsectors in the country over the last two decades. The industry is predominantly owned by Malaysians, with about 87 percent of the companies comprising small and medium scale manufacturers. The furniture subsector recorded the highest investments in 2016 (Malaysian Investment Development Authority, 2016). This record has shown that the furniture industry has not been taken lightly by the government as it is one of the main contributors to the Malaysia's economic growth. Furniture industry has been further elevated through enhancement in product innovation and creation of high-value segments, adoption of smart and sustainable manufacturing, usage of new materials, and establishment of furniture hub in the country [3].

The importance of furniture industry to Malaysia's economy that it is expected that by 2020, the industry will generate RM12billion in revenue, with employment opportunities of around 240,000 and is set to continue contributing to the nation's exports earning. On top of that, the industry aims to be the world's seventh top furniture exporter and this is in line with the National Timber Industry Policy (NATIP) [4]. In coming years, the size of the furniture industry in Malaysia will increase due to the increase of the infrastructure unit, global demand and changing customer preferences in the country. The major growth factor for furniture industry growth in the future will be the growth in the forest area of Malaysia, increasing trend of online shopping, increase in residential and commercial furniture market, and export market.

The world furniture trade was seen to be increasing for the past decade in the global furniture industry. The major problem faced in the furniture market in Malaysia has been the exchange rate fluctuation. In export market Malaysia furniture, is facing the tough competition in terms of price and design with other exporting country such as China and Vietnam. The inherent problem faced by the Malaysian furniture was that with the increasing global competition, the wooden furniture manufacturing industry is forced to improve manufacturing productivity which is fast becoming the source of competitive advantage in the industry [5]. Therefore, this research is important to examine the efficiency of the furniture industry. This issue shows that the technical efficiency need to be elevated in order to catch up with the current advanced nation for this furniture sector.

According to the statistics from the international trade and industry ministry, furniture exports charted a compound annual growth rate of about 3.5 percent between 2012 and 2016. However, automating the furniture sector is slow as it involves high cost. Malaysian Furniture Council members have claimed they would spend about 5 percent of their profit to automate operations gradually in order to grow the business and reduce labor but still have to depend on foreign labor. This is because not all of the work done by machines, some of the work requires labor such as sanding and painting. Costs of doing business in Malaysia are rising and that makes the operating environment becomes more challenging. Some manufacturers are moving elsewhere for cheaper costs.

Previous researches also have shown that the research on TE in furniture manufacturing industry in Malaysia receives less attention compared to other industries. Most of the researches such as [6] and [7] discussed on different industries in their research. Apart from that, research on technical inefficiency factors were not carried out properly in order to obtain the best technical efficiency of the firm such as [8]. [9] emphasized that with analysing the technical inefficiency factor, data in the firm level will be more reliable and important to obtain more accurate TE value. Empirical result produced using the data in the firm level will be obtaining the more significant and accurate result.

Based on the research problem, the main objective of this research is to measure the technical efficiency level of furniture manufacturing firms in Malaysia. Besides that, this study analyses the determinants of technical inefficiency in furniture manufacturing firms.

2. Literature Review

The concept of technical efficiency was basically This chapter reviews on previous research by researchers on technical efficiency concept and theory. It is also discussed on the empirical studies in which consists of local and international based in furniture manufacturing industry. This is to ensure that the defect on the previous studies will not be repeated and becomes a reference for future researchers.

2.1 Concept and Theory of Technical Efficiency

The concept of measuring efficiency of producing units was initiated by [2]. There are two basic techniques which can be used for measuring efficiency which is parametric and non-parametric. [10], and [11] developed the parametric approach which is a Stochastic Frontier Analysis (SFA) first.

Decomposition of economic efficiency can be divided into two which is technical efficiency (TE) and allocative efficiency (AE) and is defined as resource utilization to maximize the production. AE can be defined as the capability of the firm to utilize input within the cost [2]. TE is the resource utilization (input) to maximize the production (output) [12]. This technical efficiency concept becomes fundamental to the development and application of econometric frontier model. TE also is the production of output when it is given its input chosen by the producer and achievable when the firm is able to produce production at optimum level is a firm which has the best achievement [2].

Measurement of Farrell's efficiency with the assumption of constant return on a scale can be shown in Figure 2.1. YY 'isoquant line is the production boundary that reaches the level of efficiency. The form of an isoquant line represents the minimum set of inputs per unit of output required to produce a unit of production. The TE can be generated when the input combination is located along the isoquant line while the input combination point is above or at the right of the isoquant line such as point P cannot reach TE in production. While OQ / OP ratio is TE level and production allocative efficiency at point P is represented by OR / OQ ratio. The isocos CC 'line shows the objective function to minimize costs. While overall efficiency (economic efficiency) is equal to OQ / OP x OR/OQ=OR/OP.

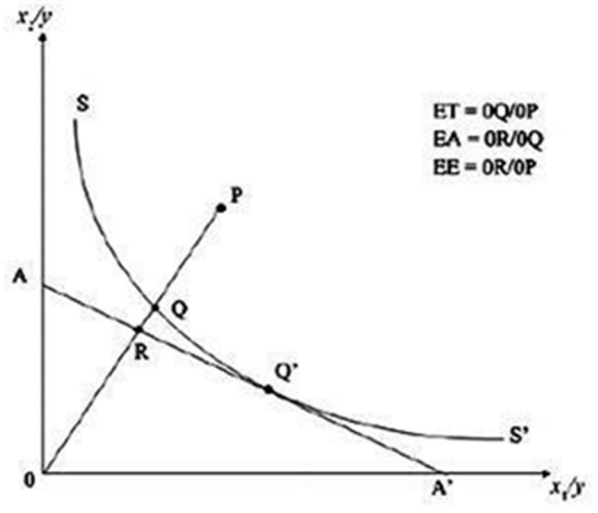

Figure 1. Illustration of Farrell's efficiency measurement 1957

2.2. Empirical Research on TE in Furniture Manufacturing Industry

TE is crucial in order to determine the efficiency level in a firm and industry. Efficiency in economics refers to

the comparison between the input and output value along with the optimum value of input and output used in the production process [13]. According to the Final Report from [14], China has shown the leading furniture exporting country since 2005 overtaking Italy. It has increase up to 80 percent over the other manufacturing sector. Similarly to China, Vietnam has also steadily climbed to be a main furniture exporter in the world. Vietnam has plenty of forest reserve giving it an advantage in furniture production.

Most of the previous research used parametric and non-parametric approach in which the most popular method to obtain a TE value. Data Envelopment Analysis (DEA) approaches is used by other researchers. Also, a research by [15] used a DEA approach to measure efficiency level. On the other hand, [16] used Stochastic Frontier Analysis (SFA) approach in their research. There are few researches which is only focuses on non-timber forest product in furniture industry such as [17]. Besides, a research by [18] and Ng & [19] only focus on technological innovation of wooden products in furniture manufacturing sector. [20] researches only focus on assessing rubberwood value-added in Malaysia furniture manufacturing sector.

In Malaysia, TE research in furniture manufacturing industry receives less attention than the other manufacturing industries. Most of the research focused more on the industrial itself without giving a mere focus on furniture sector [21]. Only a research by [16] have shown that the research is focused on TE in furniture manufacturing industry relatively and shows that it is in the positive level. It differs a lot with this research due to this research focuses on furniture manufacturing sector and takes into account on determinants factors of inefficiency. This shows that the objective context, the choice of input and output as well as the research environment are different from the previous research.

2.3 Empirical research on determinants factor of TE

Variables used in this research are based on the previous research in which gives impact on measuring the technical efficiency. There are six different determinants factor consists of labour-capital ratio, training expenses, firm size, wages rate, information and communication technology (ICT) expenses and research and development (R&D).

The first determinant factor is labor-capital ratio. Labor-capital ratio is defined as allows analysts to understand if costs are being reduced by purchasing assets to automate labor-intensive tasks. An increase to a company's capital to labor ratio over time can signal an attempt to remain competitive, or improve margins, through automation. [22] stated that capital is one of the biggest contributing factors of the output growth and productivity. Furthermore, the capital–labour ratio as the proxy of technology level is one of the important indicators in the economics efficiency [23]. According to knowledge economy not natural resources but people, their abilities, and talents – human capital, that is the main development and growth factor for the national economy. Without people it is impossible to implement further new high technologies in the scale of separate firms, industries and the country as a whole, to develop new and more sophisticated computer programs, new knowledge, etc. [24] Human capital has a significant influence on the formation of the innovative potential not only of the company but also the country as a whole. This gives additional competitive advantages to the economy of any country in the world market. And also contributes to the strengthening of economic and political influence on the world stage that naturally enhances economic development. Thus, investment increases not only in economy but also in human capital [24].

The next determinants factor is training expenses for employees. [25] stated that the effect of exercise (either in general or specific) such as workplace training (on-the-job training) has a direct relation to the increase in productivity. Skill of the workers will increase and encourage the production of the product and services with the training expenses provided. On top of that, skilled workers in the firms may contribute to the increasing the efficiency and productivity of the firm ([25] and [26]). The investment in human capital such as training to employees is a long-term asset that can provide a positive return over the period of employee service with the firms [27]. The training of the workers has shown that the increment of the efficiency of the firm that gives a significant and positive impact.

Efficiency also can be related to the scale or size of a firm if it is assumed that maintaining or improving efficiency demands a cost in terms of the firm's management. Increasing the outputs of industries to a designated scale will contribute to higher scale efficiency and improve the efficiency [28]. However, there are small firms that still work efficiently. Therefore, the research concluded that there are no strong relationship between the firm size and the TE level. The other determinants factor is wages rate. Wages rate plays an important role as a motivation to the employees to increase the efficiency and productivity level of the firm. Productivity Report (2016/2017) [29] shows that the wages rate given to the worker ensure the increment of the technical efficiency

and productivity of the firm. Apart from that, the determinants factor of the efficiency is the expenses of information and communication technology (ICT). There are few previous research shows that the ICT in the developed country is very important. The investment on ICT increases the productivity level of the firm.

Last but not least, research and development (R&D) is one of the determinant factors of technical efficiency. Human-capital and in-house research and development activities are often focused on solving-problems and reducing cost [30]. Therefore, it will increase the efficiency of the firm.

3. Methodology

This chapter stated on research methodology to determine the TE value and the factors affecting technical inefficiency. The first part elaborates on SFA model used in detailed to analyze the TE value. This explains on SFA specification model which is Translog model stochastic frontier production. On top of that, variables definition also is explained in this chapter. Furthermore, this chapter discuss on the sources of the data and the instrument of the research.

3.1 SFA Approach

SFA is a stochastic model and therefore is able to differentiate between inefficiency and noise. On the other hand DEA is a non-parametric model and thus a function need not be defined. Therefore, the effects of the form might not get mixed with those of inefficiency [31].

SFA model originated from [10] and [11] and shortly later by [32]. [9] propose a model for technical inefficiency effects in a stochastic frontier production function for panel data. Provided the inefficiency effects are stochastic, the model allows for the estimation of both technical change in the stochastic frontier and time-varying technical inefficiencies [33] These SFA model used in order to obtain a firm TE value. The efficiency at the firm level can be measured by estimating SFA production frontier model which is affected by the sample achievement or the best firm to show that the technological changes used in the industry.

3.1.1. Transcendentral Logarithm (Translog) Study & Model Specification

The stochastic frontier production model based on the Translog function is written as follows;

$$lnY_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \beta_3 \ln II_i + 1/2\ \beta_4 (\ln K_i)^2 + 1/2\ \beta_5 (\ln L_i)^2 + \beta_6 (\ln II_i)^2 + \beta_7 (\ln K_i \times \ln L_i) + \beta_8 (\ln K_i \times \ln II_i) + \beta_9 (\ln L_i \times \ln II_i) + (v_i - u_i) \quad (1)$$

Where is the log for the amount of nominal output of the i-th firm, K is the log for the amount of nominal asset of the i-th firm. Whereas, L is the log for the amount of labour for the i-th firm and is the random variable or random effect, identical and normally distributed (independent and identically distributed, IID), normally distributed with [N(0, σ2v)]. Meanwhile, is the non-negative random variable that can be assumed to explain inefficiency in production which is normally assumed to be IID as truncated at zero for distribution [N(μi, σ2u)].

Based on this study, the TE value obtained is from 2015 as this study only takes one year for research. The variables incorporated within the technical inefficiency component of the SFA model are as follows:

$$u_i = \delta_0 + \delta_1 \ln(C/L)_i + \delta_2 \ln(TRN)i + \delta_3 \ln(SD/L)_i + \delta_4 \ln(TD/L)_i + \delta_5 \ln(WR/L)_i + \delta_6 \ln(ICT)_i + \delta_7 \ln(R\&D)_i + \delta_8 (DFSME) \quad (2)$$

Where u_i is technical inefficiency, C/L_i represents the total capital ratio divided by the number of employees for the *i*-th firm, TRN represent the amount of employee training expenses for the *i*-th firm, SD/L_i represents the ratio of employees trained at diploma level and STPM or equivalent for the *i*-th firm, TD/L_i represents the ratio of employees trained at higher level including advanced degree or equivalent for the *i*-th firm, WR/L_i is the wage rate for the *i*-th firm, is the communication cost for the *i*-th firm, & is the research and development needed for the *i*-th firm, and DFSME is the dummy for the *i*-th firm with small firms size represent 1 and others are considered 0.

3.2 Sources of Data

This research used data in the firm level of the furniture manufacturing industry obtained from IMS DOS. The choices of firms are provided by DOS based on the needs and objectives of the research which consists of dependent and independent variables. The data chosen are random through stage simulation including identifying larger, medium and small firm, total output for production, total number of workers and capitals used. Even though the total data is only 30 percent, the result obtained is efficient. Based on the original data provided by DOS, filtering information must be done due to some firms have less occupied information such as the capital and output values are not clear. The objective of the research is to measure the TE value based on the data in the firm level using computer software named FRONTIER 4.1. The software used a programming language of Fortran77 which is a software used specifically to estimate the stochastic frontier

production. Microsoft Office Excel 2013 is used to help in analyzing and calculating data in order to align with the format used in FRONTIER 4.1.

4. Results and Discussion

This chapter discussed on the results obtained from the research quantitatively analyzed using the SFA approach. The result and analysis is discussed accordingly to research question and research objective which needed to achieved. This section also discussed on the analysis of technical efficiency level using SFA approach. Furthermore, the analysis of SFA result and the technical inefficiency factor is also discussed.

4.1 Descriptive Statistics

Based on data obtained from the Department OF Statistics (DOS), in 2015, 586 firms were involved in This study was conducted on 710 furniture manufacturing firms in Malaysia in 2015. Table 1 shows a descriptive statistics of the variable used for SFA estimation. The table exhibits the overall average amount of output produced by the furniture manufacturing firms which was RM 14 million with a minimum of RM 2 billion to a maximum of RM 278 million. Capital is a major expense for furniture manufacturing firms with the average spending of RM 5 million between RM 7,000 to RM 109 million. On top of that, the average number of employees employed was 91 persons ranging from 4 to 2, 284 workers. The study also found that the ratio between capital and labor in furniture manufacturing firms ranged from RM 44 to RM 2 million with an average of RM 66,000. Furthermore, the furniture manufacturing firms had spent an average of RM 21,000 with expenditures ranging from RM 0 to RM 2.6 million for the cost of employee training.

In addition, the average ratio of employees with higher qualification including advanced degree and equivalent was 0.063 ranging from 0.000 to 0.731. As for the ratio of employees having a diploma and Malaysian Higher School Certificate or equivalent, it shows an average range of 0.140 ranging from 0.000 to 0.909. Furthermore, the firms' employee average wages in the year of 2015 was RM 24,000 ranging between RM 10,000 to RM 112,000. The firms had also spent an average of RM 31,000 for ICT with minimum spending of RM 0 and maximum spending of RM 2 million. Furniture manufacturing firms also spent an average of RM 24,000 with expenditures ranging from RM 0 to RM 3 million. Meanwhile, SME dummy showed that 90 percent of the firms involved in this study were small-sized and medium-sized firms. Standard deviation showed that the variance fell over the entire sample.

Table 1. Descriptive statistics of the variable

Variable		Mean	Minimum	Maximum	Std. deviation
Y	(RM)	14,281	2,128	278,741	25992.832
K	(RM)	5,193	7	109,004	10879.965
L		91	4	2,284	157.781
K/L	(RM)	66.174	0.435	2018.597	135.126
TRN	(RM)	21.150	0	2600.790	153.912
Ratio TD	Ratio	0.063	0.000	0.731	0.0682
Ratio SD	Ratio	0.140	0.000	0.909	0.128
WR/L	(RM)	23.739	10.722	112.893	9.053
ICT	(RM)	31	0	2,256	122.032
R&D	(RM)	24.140	0	3,562.500	156.887
DFSME	Number	0.924	0	1	0.265

Notes: Y = output; K = capital; L = labor; K/L = ratio of capital labor; TRN = employee training expenses; TD/L = ratio of employees trained at a higher level including advanced degree or equivalent; SD/L = ratio of employees trained at diploma level and Malaysian Higher School Certificate or equivalent; WR/L = wages rate; ICT = communication cost; R&D = research and development cost; DFSME = dummy for small-medium firms size

4.2 Technical Efficiency Analysis

Table 2 displays the frequency and the index distribution of technical efficiency in the furniture manufacturing firms in Malaysia in 2015. This finding describes the contribution of technical efficiency of a firm in furniture manufacturing industry. The furniture manufacturing industry consists of 710 firms. If scrutinized closely, the frequency and index distribution of technical efficiency that range between 0.91 and 1.00 were the highest range of the overall industry, i.e. 45.46 percent, followed by index distribution of technical efficiency between 0.81 and 0.90 with a slight difference which was 45.35 percent. Meanwhile, the least frequency and index distribution of technical efficiency is range between 0.71 and 0.80 were the lowest of overall industry which is 9.16 percent. These results were driven by higher demand due to the rapid economic growth of between 0.8 percent to 6 percent per annum and increase in purchasing power. Thus, firms have increased the level of efficiency using modern technology and improving the skills of employees (MITI, 2013) [34].

Table 2. Frequency and index distribution of technical efficiency based on industry of furniture manufacturing firms in Malaysia

Percent	Firms	TE Range
≤ 0.2	0	0
0.21-0.30	0	0
0.31-0.40	0	0
0.41-0.50	0	0
0.51-0.60	0	0
0.61-0.70	0	0
0.71-0.80	65	9.155
0.81-0.90	322	45.352
0.91-1.00	323	45.455

4.3 Determinants of Technical Inefficiency

Table 3 illustrates the result of parameter estimator of stochastic frontier production model 2015 using FRONTIER 4.1 which was developed by [9] The result of the analysis shows that the most input parameter estimator in furniture manufacturing industry is significant at 1 percent significant level. Each input can be explained by the significant output. When there was an increase of 1 percent in the wages, the total output increased by 0.179 percent. The gamma value based on the analysis conducted is 0.038. The significant technical inefficiencies had a significant impact on the level and production change of furniture manufacturing firms in this research. Apart from that, parameter sigma-squared is also significant in implying that firms that operated in an inefficient manner, and budgeting of stochastic frontier production model is better than the average production model in analyzing industrial production processes.

Table 3. Parameter estimation of stochastic frontier production model

Variable	Coefficient	t-ratio
Constant (β0)	3.425	7.394***
LnCapital (β1)	0.121	2.008
LnLabor (β2)	0.522	5.305
0.5(LnK*LnK) (β3)	0.099	0.910
0.5(LnL*LnL) (β4)	0.013	2.116
LnK*LnL (β5)	0.137	6.889
Sigma-square	0.026	17.493***
Gamma (γ)	0.038	2.531***
Log likelihood function	288.516	
LR test of the one-sided error	90.756	

Notes: *, **, *** significant at 10%, 5% and 1% levels respectively

Based on Table 4, several variables of technical inefficiency are significant except ratio of capital-labor, ratio of employees with secondary education, cost of ICT and R&D, and the dummy firm's size. The negative sign indicates that an increase in the variable will decrease the technical inefficiency while the positive sign indicates otherwise. Wages rate plays an important role with real coefficient of -0.179 and significant at 1 percent significant level. This shows that when the employees' wages increase by 1 unit, the technical inefficiency decrease by 0.002 points. Based on the annex from Bank Negara Malaysia, it stated that there was an increase of 0.8 percent in the wages paid to the employees in furniture manufacturing firms. This shows that an increase in wages to employees can motivate employees to improve their productivity and ultimately increase the amount of production output at an optimal level ([35]; [36], [37]). Productivity Report (2016/2017) [29] shows that the wages rate given to the worker ensure the increment of the technical efficiency and productivity of the firm.

Besides that, employees training expenses is also significantly influence output at 5 percent significance level. When the training expenses cost increase by 1

unit, the technical inefficiency will decrease by 0.017 percent. [38]. [39] stated that firms need to invest on the training expenses as a long-term asset which the employees will give a positive feedback during their service for the company. In fact, [40] stated that training expenses for the employees are significant in determining the technical inefficiency of the firm.

Table 4. Determinants of technical inefficiency

Variable and Parameter	Model SF	t-value
Constant	0.859	5.740***
LnRatio of capital-labor	-0.022	-0.846
LnEmployee training expenses	-0.017	-1.989**
LnRatio of TD	-0.418	-3.355***
LnRatio of SD	-0.043	-0.584
LnWages Rate	-0.179	-8.029***
LnICT	-0.010	-1.112
LnR&D	-0.003	-0.491
Dummy firm size	-0.049	-1.165

Notes: *, **, *** significant at 10%, 5% and 1% levels respectively

5. Discussion

This study aims to measure the level of efficiency and analyse the determinants of the technical inefficiency of furniture manufacturing industry in Malaysia. The analysis was based on data gathered from DOS comprises of 710 firms involved in furniture manufacturing firms in Malaysia. The findings were obtained through the function of Translog production being selected to investigate the efficiency level and determinants of firms' inefficiency. All in all, the level of technical efficiency of furniture manufacturing industry is good.

The following findings indicate that the regression result reveals that determinant such as employees' wages rate is significant in reducing firm's inefficiency. Meanwhile, the ratio of capital-labour is found to have positive relationship since the result shows its decrease causes firm inefficiency. In conclusion, furniture manufacturing firms in Malaysia should take initiatives to improve employees' wages rate for the purpose of improving employees' productivity and motivation which will eventually increase the amount of production in the future. The increase in wage payment can be given based on the work factors such as duties, responsibilities and work condition should be taken into account when firms are considering raising employees' wages rate.

This research however has a limitation. It is difficult to access to firm's data. Most of the employers were reluctant to cooperate in answering questionnaires submitted by DOS. This has caused difficulties in obtaining extensive firms' data which is valuable for this study. Based on the limitations that have been encountered in this research, the following are some recommendations for further research. First, increase the number of existing firms in order to obtain more comprehensive technical competence result. Second, additional variable that affect technical inefficiency can be investigated such as exports and imports. Third, construct a further research to identify and compare the result of using two different approaches in modelling the SFA and DEA (data envelopment analysis). The comparisons of the result can indicate whether there are differences or similarities in the obtained results.

Acknowledgement

The authors would like to express the deepest appreciation to the Department of Statistic Malaysia for providing the data and Registrar Universiti Tun Hussein Onn Malaysia for funding this project.

References

[1] Koopmans, T. C., An Analysis of Production as an Efficient Combination of Activities, Activity Analysis of Production and Allocation. TC Koopmans. Ed.). Wiley. New York, 1951.

[2] Farrell, M. J., "*The measurement of productive efficiency*", Journal of Royal Statistical Society. Series A(General), Vol 120, No 3, pp.253-290, 1957.

[3] National Export Council. (2017). Press Release: Malaysia's Furniture Sector Recognized Globally. Kuala Lumpur: MATRADE.

[4] NATIP (National Timber Industry Policy). (2009). NATIP National Timber Policy 2009-2020. Ministry of Plantation Industries and Commodities, Malaysia.

[5] Ratnasingam, J., Ark, C. K., Mohamed, S., Liat, L. C., Ramasamy, G., & Senin, A. L., "*An Analysis of Labor and Capital Productivity in the Malaysian Timber Sector*", BioResources, Vol 12, No 1, pp.1430-1446, 2017.

[6] Sulaiman, N., & Rashid, Z. A., "*Decomposition of productivity growth of the malaysian manufacturing sector, 1983-2005*". Jurnal Ekonomi Malaysia, Vol 47, No 1, pp.65-74, 2013.

[7] Zhou, Y., FDI and Technical Efficiency in Manufacturing Firms: A Stochastic Frontier Approach. Master's Theses. 95, 2014. https://repository.usfca.edu/thes/95

[8] Sulaiman, N., "*An input-output analysis of the total factor productivity growth of the Malaysian manufacturing sector, 1983-2005*". Jurnal Ekonomi Malaysia, Vol 46, No 1, pp.147-155, 2012.

[9] Battese, G. E., & Coelli, T. J., "*A model for technical inefficiency effects in a stochastic frontier production function for panel data*", Empirical economics, Vol 20, No 2, pp.325-332, 1995.

[10] Aigner, D., Lovell, C.K. & Schmidt, P., "*Formulation and estimation of stochastic frontier*

production function models", Journal of Econometrics, Vol 6, No 1, pp.21–37, 1977.

[11] Meeusen, W. & van den Broeck, J., Efficiency Estimation from Cobb-Douglas Production Functions With Composed Error. International Economic Review 18, 435-444. 1977.

[12] Odeck, J., & Brathen, S., "*A meta-analysis of DEA and SFA studies of the technical efficiency of seaports: A comparison of fixed and random-effects regression models*", Transportation Research Part A. pp.1574-1585, 2012.

[13] Karlaftis, M.G., & Tsamboulas, D., "*Efficiency measurement in public transport: Are findings specification sensitive?*", Transportation Research Part A: Policy and Practice, Vol. 46, (2), pp. 392-402, 2012.

[14] Academy of Science Malaysia (ASM). Final Report: Furniture Industry Sector. Mega Science 3.0. Kuala Lumpur: ASM, 2015.

[15] Mujaddad, H. G., & Ahmad, H. K., "*Measuring Efficiency Of Manufacturing Industries in Pakistan: An Application of DEA Double Bootstrap Technique*". Pakistan Economic and Social Review Vol 54, No. 2 pp. 363-384, 2014.

[16] Radam, A., Yacob, M. R., & Muslim, H. F. M., "*Technical Efficiency of the Malaysian Wooden Furniture Industry: A Stochastic Frontier Production Approach*", International Business Research, Vol 3, No 3, 10, 2010.

[17] Cabuy, R. L., Marwa, J., Manusawai, J., & Rahawarin, Y. Y., Non-woody plant species of Papuan Island forests, a sustainable source of food for the local communities, 2012.

[18] Han, X., Wen, Y., & Kant, S., "*The global competitiveness of the Chinese wooden furniture industry*", Forest Policy and Economics, Vol 11, No 8, pp.561-569, 2009. http://dx.doi.org/10.1016/j.forpol.2009.07.006

[19] Ng, B. K., & Thiruchelvam, K., "*The dynamics of innovation in Malaysia's wooden furniture industry: Innovation actors and linkages*", Forest Policy and Economics, Vol 14, No 1, pp.107-118, 2012.

[20] Zakaria, N. A., Merous, N. H., & Ahmad, I. "*Assessment of Rubberwood Value-Added in Malaysia's Wooden Furniture Industry*", International Journal of Economics & Management, Vol 8(1), 2014.

[21] Radam, A., Ahali, N. M., & Baharom, A. H., "*Technical efficiency of manufactured rubber product in Malaysia: A Stochastic frontier analysis*", Elixir production Vol 42. Pp.6466-6471, 2012.

[22] Katz, J. M., Production Functions, Foreign Investment and Growth: A Study Based on the Argentine Manufacturing Sector 1946-1961. North-Holland Publishing Company, 1969.

[23] Fang, C. Y., Hu, J. L., & Lou, T. K. "*Environment-adjusted total-factor energy efficiency of Taiwan's service sectors*", Energy Policy, Vol 63, pp.1160-1168, 2013.

[24] Forrester, S. V., Ustinova, G. H., Kosyakova, I. V., Ronzhina, N. V., & Suraeva, M. O., "*Human capital in the innovative conditions*", International Electronic Journal of Mathematics Education, Vol 11, No 8, pp.3048-3065, 2016.

[25] Essmui, H., Berma, M., Shahadan, F. B., Ramlee, S. B., & Mohd, M. F. B., "*Structural Equation Model for Analyzing the Impact of Business Environment on Firm's Growth. International*", Journal of Economics and Finance, Vol 6, No 9, pp.177, 2014.

[26] Ismail, R., & Zainal Abidin, S., "*Efficiency level of Malay-owned firms and the recurrent determinant factors in the Malaysian service sector*", International Bulletin of Business Administration, Vol 6, pp.6-18, 2009.

[27] Fahmy-Abdullah, M., & Talib B. A., "*Data Envelopment Analysis (DEA) Approach in Efficiency Transport manufacturing Industry in Malaysia*", International Journal of Engineering and Technology, Vol 7, No 3.20, 2018.

[28] Li, H., & Shi, J. F., "*Energy efficiency analysis on Chinese industrial sectors: an improved Super-SBM model with undesirable outputs*", Journal of Cleaner Production, Vol 65, pp.97-107, 2014.

[29] Malaysia Productivity Corperation Report 2015 and 2016. Produktivitas Nasional Corporation, Petaling Jaya: Kuala Lumpur.

[30] Ratnasingam, J., Wai, L. T., Thanasegaran, G., Ioras, F., Vacalie, C., Coman, C., & Wenming, L., "*Innovations in the forest products industry: The Malaysian experience*", Notulae Botanicae Horti Agrobotanici Cluj-Napoca, Vol 41, No 2, pp.601-607, 2013.

[31] Lampe, H. W., & Hilgers, D., "*Trajectories of efficiency measurement: A bibliometric analysis of DEA and SFA*", European Journal of Operational Research, Vol 240, No 1, pp.1-21, 2015.

[32] Battese, G. E., & Broca, S. S., "Functional forms of stochastic frontier production functions and models for technical inefficiency effects: a comparative study for wheat farmers in Pakistan", Journal of productivity analysis, Vol 8, No 4, pp.395-414, 1997.

[33] Akkaya, O., "*Cost efficiency analysis of Swedish financial enterprises: An empirical investigation*", European Research on Management and Business Economics, Vol 22, No 1, pp.31-37, 2016.

[34] MITI. (2013). National automotive policy 2013. Kuala Lumpur: Ministry of International Trade and Industry.

[35] Fahmy-Abdullah, M., "*Technical efficiency and total factor productivity in transport manufacturing firms in Malaysia*", Doctoral dissertation, Universiti Kebangsaan Malaysia, Malaysia. 2017. https://doi.org/10.21315/aamj2017.22.1.3

[36] Fahmy-Abdullah, M., Sieng, L.W., & Isa, H.M. "*Technical efficiency in Malaysian textile manufacturing industry: A Stochastic Frontier Analysis (SFA) approach*", International Journal of Economics and Management, Vol 12, No 2, pp.407–419, 2018.

[37] Fahmy-Abdullah, M., Sieng, L. W., & Ridzuan, S., "*Data envelopment analysis (DEA) two stages in*

identify determinants factor of efficiency techniques for transport in manufacturing firms", Sains Malaysiana, Vol 48, No 4, pp.901–908, 2019.

[38] Hall, R. E., "*The importance of Lifetime Jobs in the U.S Economy*", American Economic Review. 716-24, 1982.

[39] Fahmy-Abdullah, M., Ismail, R., Sulaiman, N., & Abdul Talib, B., "*Technical efficiency in transport manufacturing firms: Evidence from Malaysia*", Asian Academy of Management Journal, Vol 22, No 1, pp.57– 77, 2017. https://doi.org/ 10.21315/aamj2017.22.1.3

[40] Ng, Y. C., & Li, S. K., "*Training and productive efficiency in transition economies*", Oxford Economic Papers, Vol 55, No 4, pp.607-624, 2003.