



Innovation and technical efficiency in Malaysian family manufacturing industries

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ABSTRACT

This study investigates the technical efficiency for each industry in the Malaysian manufacturing sector is estimated by using Data Envelopment Analysis (DEA). In order to pursue a balance of innovation between long-term and short-term performance strategy, we integrate the Balance Scorecard (BSC) approach with DEA. Furthermore, this paper looks at the determinants of efficiency using the Tobit regression model. In measuring the level of firms' efficiency and innovation, the wood and wood based products industry is emphasized due to its importance in the economic growth of manufacturing sector. In the wood and wood based products industry, the highest level of technical efficiency was achieved by two sub-sectors i.e. veneer sheets and plywood and laminboard, particle board and other panels board, with the mean value of technical efficiency of 1.081 and 1.097 respectively. Generally, the majority of the manufacturing firms are operating technical inefficiently. The distribution of DEA and DEA-BCS technical efficiency in Malaysian Manufacturing Industries show that most of the industries have the average technical efficiency scores greater than 1.05 with only 7 industries (13.21%) in DEA-BSC model operating at or near to the most optimal productions.

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1.0 Introduction

Previous research acceded that there are myriad of definitions and usage of the term innovation (Jain, 2010). Although formal definitions of innovation appear diverse, one common element in all definition of innovation is novelty. For the purpose of this study, innovation is defined as "the commercially successful exploitation of new technologies, ideas or methods through the introduction of new products or process, or through the improvement of existing ones.

There is clear evidence that innovation play a crucial role to long term profitability and growth in firms (Freel, 2000). There can be little doubt that today's firms must be able to move in the world of innovation. The successful firms will be firms which fully understand innovative business differs from non innovative business and is able to respond accordingly thereby successfully "being innovative".

The importance of manufacturing sector in contributing to Malaysian economic growth is not deniable. With this rapid expansion of the manufacturing sector in the last three decades has transformed Malaysia from an

agricultural based economy to a rapidly industrializing country (Ministry of International Trade and Industry, 2008)

During the period of 1996 to 2005, the trade and economic policy undertook progressive liberalization to achieve the long-term objectives of freer and open trade as well as strengthening the domestic capacity to participate in an increasingly open trading environment. Additionally, this export-led growth is vital in the present transition for Malaysia's economy to transform into the high-tech and capital-intensive industries as well as manufacturing related services (Third Industrial Master Plan, 2006 - 2020).

Most of the industrialized countries like Japan, USA and other G8 countries have a strong base of manufacturing industry in order to achieve higher economic growth. In tandem with the objective to transform into the high-tech and capital-intensive industries, it is vital in strengthening the manufacturing firm sectors to improve productivity. The majority of manufacturing firms adopt low technology and the majority of workers are with low educational level too. Attempts are made in Malaysia to create favorable conditions for the growth of manufacturing firms, especially by establishing lending institutions for financing of manufacturing firms, worker and/or management training centers, and industrial zones (Third Industrial Master Plan, 2006 - 2020). As Arrow (1977) notes, market failures in developing countries often constraint the ability of firms to achieve first-best efficiency. Therefore, an improved understanding of the factors influencing efficiency can enhance the ability of policy makers to assist growth of manufacturing firms.

One of the pertinent issues facing the manufacturing firms is inability to produce efficiently due to lack of skills and low technology. With limited resources in hand, the likely strategy is to optimize its utilization, reducing cost of production and able to be at the competitive edge when the firms are operating efficiently. Additionally, the improvement in national competitiveness depends highly on increasing productivity in manufacturing industries and the firms must have a good combination of inputs, where the majority will be laid to human capital.

In a small and open economy like Malaysia, productivity enhancement of the manufacturing sector is especially crucial in the growth and continuous development of the economy. Thus in this analysis will evaluate the efficiency of Malaysian manufacturing industry and attempts to identify its influencing factors.

The remainder of the paper is organized as follows. Section 2 reviews the relevant theoretical literature on performance and efficiency. In section 3, we discuss the methodological framework of Data Envelopment Analysis (DEA), balanced scorecard (BSC) and Tobit regression. Next, section 4 discusses the empirical results on technical efficiency of the wood and wood based products industries. Then the analysis is extended to include all sub-industries of the manufacturing sector in Malaysia to conduct comparative efficiency analysis, first, by individuals sectors then by pooling all industries together based on the three and five digits MSIC code. Further, the determinants of firms' performance and efficiency across the manufacturing industries will be identified using the Tobit model. The final section summarizes all the findings and concludes the study.

2.0 Literature review

Data Envelopment Analysis (DEA) was created with the primary purpose to compute the technical efficiency of the firms. In measuring technical efficiency, the transformation of inputs such as employee and raw materials into outputs is compared to the best practice firms.

Charnes et al. (1978) were the first to describe the DEA model (the CCR model) which assuming the circumstance is the constant return to scale and used a mathematical programming model to identify the efficiency frontier based on the concept of the Pareto optimum when using multiple measures. The BCC model assumes under a variable returns to scale setting which introduced by Banker et al. (1984) that used the four postulates of production possibility aggregation and Shephard's distance function for measuring the technical efficiency (TE) and scale efficiency (SE). The operation of different returns to scale which may causes the inefficiencies, and thus a thorough understanding of the state of returns to scale of specific decision-making units can offer the information required by an administrator to further improve the firms' efficiency (Boussofiane et al., 1991).

Kaplan and Norton (1993) introduced the concept of Balanced Scorecard (BSC) which is not only a tool for performance assessment, but it also overcomes the drawbacks of traditional performance assessment by putting in the factors of environmental diversification and considers finance, customer, internal process, and learning and growth dimensions together in order to respond to environmental competition and challenges.

Jackson (1999) pointed out that the uncertain nature of strategies was the main reason for firms to focus on short-term financial gains. Therefore the performance indicators in Balance Scorecard should be set on the basis of business success factors and should be closely linked with organization's operational strategies and compensation policies. The advantage of Balanced Scorecard was that it helped business to put organizational strategies, organizational structure, and business visions together as the core of management system (Chow et al., 1997). By implementing the BSC, business organization is able to turn its long-term operational strategies into action and reach the balance between long-term competitiveness and short-term financial profits.

DEA is often supplemented with regression analysis to identify the significant factors contributing to superior performance of the DMUs on the frontier. One of those regression analyses is Tobit regression model which was first suggested in econometrics literature by Tobin (1958). In the first stage they use DEA and calculate the efficiency scores using traditional inputs i.e., variables that are controlled by DMUs. The second stage involves the use of Maximum Likelihood estimation of the Tobit regression model and provides efficiency measures based on variables that are not included in the DEA.

Danlin, et al. (2001) studied technical efficiency in cotton industry in the Soviet Union by using a similar approach as above. Besides that, a similar procedure is conducted in transportation studies. For example, Oum and Yue (1994) use DEA efficiency scores with a Tobit model to analyses the influence of certain variables on the performance of European railways as did Kerstens (1996), who evaluates the performance of French urban transit companies.

Chen and Yeh (2005) applied DEA to analyze the comparative performance of the six high-tech manufacturing industries currently developed in Taiwan. The results show that the semiconductor and computer industries are the best performers, but the biotech industry has the worst performance. Meanwhile, communications, photo-electronics, and precision equipment industries have medium performance, while the communications and photo-electronics industries have a satisfactory average scale efficiency score, but a poor pure technical efficiency score.

In Malaysia, Mohd Noor and Ismail (2004) studied technical efficiency and its determinants for 138 manufacturing firms. This study found that level of mechanization and firm size significant positively determined the level of technical efficiency. By using DEA and Tobit model, Rahmah Ismail and Noorasiah Sulaiman (2007) showed that the majority of Malay firms in manufacturing sector are operating inefficiently. More efficient firms are found in the metal and fabricated metal products. They found that the important factors that determine positively level of firms' efficiency are percentage of R&D expenditure, percentage of training expenditure and level of technology. Despite that, not all types of industry portray these variables as efficiency determinants.

Given the literature, we examine the determinants of efficiency under five broad headings (Caves, 1992; and Mayes et al. 1994). First, lack of competition is believed to induce inefficiency. A measure is used to estimate the effects of competitive conditions on inefficiency: advertising and promotional expenses. Second, the structural heterogeneity between firms can lead to structural efficiency differences. These may include patent, export and import of raw materials and packing materials. Third, managerial and organizational factors may affect the activities of any firm. These factors include staff training cost, firms' oversea investment and number of staff where the number of staff is one of the indicators to determine the firm size. Fourth, dynamic factors are thought to foster efficiency. These include research and development expenditure, information technology expenses, E-commerce sales and purchases. Finally, public policy may influence the incentives to improve efficiency.

3.0 Methodology framework

3.01 Technical and allocative efficiency

Farrell (1957) introduced a measure of efficiency to take into account all inputs and outputs which is known as technical efficiency. The firm is analyzed within a group of comparable firms and is evaluated by comparing it with some ideally performing firm. This ideally performing firm is found by one of the following means.

(i) Theoretical - the entire process is represented as a theoretical or "ideal" production function where the outputs produced by the process are represented as a function of the inputs. This function provides the expected performance and the ideally performing firm from the comparison.

(ii) Empirical - unlike the theoretical approach that is impossible to operationally achieve, the performance of the firm is determined by comparing it to a relative production combination that is achievable in practice.

By definition (Farrell 1957), the total economic efficiency of the firm P is defined as follows:

Total economic efficiency = Allocative efficiency x Technical efficiency

The CCR Model

Charnes, Cooper and Rhodes (1978) developed a fractional programming model to determine the efficiency score of each of the firms in a data set of comparable units which is known as the CCR model. This model determines the best set of weights for each firm when the problem is solved for each firm under consideration. The CCR model is a fractional program. In order to solve the CCR model easily, the model has to be converted into a linear program.

$$\begin{aligned} \text{Max } h_0 &= \sum_{r=1}^s \mu_r y_{rj_0} && \text{for firm}_0 \\ \text{Subject to } &\sum_{i=1}^m v_i x_{ij_0} = 1 \\ &\sum_{r=1}^s \mu_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0 && j = 1, 2, 3, \dots, n \\ &v_i \geq \epsilon && i = 1, 2, 3, \dots, m \\ &\mu_r \geq \epsilon && r = 1, 2, 3, \dots, s \end{aligned}$$

The above model is developed from the fractional program and the input and output variables are multiplied with their respective weights, therefore it is known as the multiplier model. This model has $m+s$ variables and $1+n+m+s$ constraints.

The BCC Model

A modification to the CCR (constant returns to scale) model by adding a convexity constraint was presented by Banker, Charnes, Cooper (1984). The presence of the convexity constraint decreases the feasible region from conical (or convex cone) hull in CCR to convex hull of firms. All firms were assumed to be efficient in their current scale so that the efficiency measured was independent of scale considerations (variable returns to scale) which now the model is known as BCC.

The production possibility set in the figure is the set of all technically feasible combinations of inputs and outputs, representing the technology of a firm. The envelopment form of the BCC model would be the same as the dual for the CCR model but with an additional constraint,

$$\sum_{j=1}^n \lambda_j = 1$$

Balanced Scorecard (BSC)

The BSC is a methodology aimed at revealing problem areas within organizations and pointing out areas for improvement which was first proposed by Kaplan and Norton (1992, 1996). Wright et al. (1999) proposed BSC for firms looks at the four perspective such as financial, customer, internal process, and learning and innovation in order to aid in the gathering and selection of the appropriate performance measures for the firm.

Combining the Balanced Scorecard and the DEA Model

DEA model always identifies the most suitable weights for the output and input items and then calculate its efficiency, but it cannot be directed against the historical evolution trend of every firm’s present operational focal point, which is the goal necessary to determine its performance. The combination of financial proportion indices and the DEA model can overcome this shortcoming and revise the DEA model, regarding financial indices as output items for conducting the performance assessment.

Second-Stage Tobit Model

It is also of considerable interest to explain the DEA efficiency scores after having measured the relative efficiencies. The results of investigating the determinants of technical efficiency are expected to be able to guide policies which aimed at improving performance of the industries. In the first stage DEA is use and calculate the efficiency scores using inputs whilst in the second stage involves the use of Maximum Likelihood estimation of the Tobit regression model and provides efficiency measures based on variables that are not included in the DEA.

DEA efficiency scores are transformed using the following formula (Fethi, 2000):

$$y_i = \eta_i - 1$$

For this purpose, the standard Tobit model can be defined as follows for observation (firm) i:

$$y_i^* = \beta'x_i + \varepsilon_i$$

$$y_i = y_i^* \text{ if } y_i^* > 0, \text{ and}$$

$$y_i = 0, \text{ otherwise } \square,$$

where $\varepsilon_i \sim N(0, \sigma^2)$ x_i and β are vectors of explanatory variables and unknown parameters, respectively.

The y_i^* is a latent variable and y_i is the technical efficiency score.

The likelihood function (L) is maximized to solve β and σ based on the observations (firms) in each industry of y_i and x_i is

$$L = \prod_{y_i=0} (1 - F_i) \prod_{y_i>0} \frac{1}{(2\pi\sigma^2)^{1/2}} \times e^{-[1/(2\sigma^2)](y_i - \beta'x_i)^2}$$

Where

$$F_i = \int_{-\infty}^{\beta'x_i/\sigma} \frac{1}{(2\pi)^{1/2}} e^{-t^2/2} dt$$

The first product is over the observations for which the firms are 100% efficient ($y = 0$) and the second product is over the observations for which firms are inefficient ($y > 0$). F_i is the distribution function of the standard normal evaluated at $\beta'x_i/\sigma$.

4.0 Data analysis and results

4.01 Technical efficiency of the wood and wood based products industry

The wood and wood based products industry consist of six main sub-sectors which are sawmilling and planing of wood; manufacture of veneer sheets and plywood; manufacture of laminboard, particle board and other panels and board, manufacture of builders' carpentry and joinery, manufacture of wooden and cane containers; and manufacture of wooden and cane furniture.

The technical efficiency estimator is measured through output orientated approach, which will produce efficiency at CRS and VRS technologies. With output orientated approach, the firm's performance will be determined through their ability in maximizing production output by using combination of input.

In table 1 of appendix below and according to CRS results, manufacture of laminboard, particle board and other panels and board indicated the highest percentage of firms (47.27%) that are fully efficient followed by veneer sheets and plywood (29.41%), wooden and cane containers (26.39%), builders' carpentry and joinery (9.47%), sawmilling and planing of wood (6.27%), and wooden and cane furniture (6.12%), respectively. The majority of firms in wood products manufacturing industries have an CRS efficiency score of more than 1.1 especially the firms in the industry of the sawmilling and planing of wood, the builders' carpentry and joinery, wooden and cane container, and the wooden and cane furniture.

The estimation of technical efficiency at VRS produces a higher score. According to VRS results, the analysis shows that manufacture of laminboard, particle board and other panels and board indicated the highest percentage of firms (60%) that are fully efficient which is the firms have efficient operation of the firm itself followed by veneer sheets and plywood (49.58%), wooden and cane containers (43.06%), builders' carpentry and joinery (30.04%), sawmilling and planing of wood (10.98%), and wooden and cane furniture (17.93%), respectively.

Scale efficiency is defined as the ratio of overall efficiency (CRS) to pure technical efficiency (VRS) which is the measure of the ability to avoid waste by operating at or near to the most productive scale. According to SE results, the analysis shows that manufacture of laminboard, particle board and other panels and board indicated the highest percentage of firms (65.45%) that are fully scale efficient followed by veneer sheets and plywood (40.34%), wooden and cane containers (33.33%), and lowest in sawmilling and planing of wood (20.03%), builders' carpentry and joinery (11.93%), and wooden and cane furniture (8.13%).

Table 2 of appendix below shows descriptive statistics of technical efficiency by industry. In general, the mean value of technical efficiency is between 1.097 and 2.5041 under CRS specification, where the mean value of each sub-sector is calculated by the geometric mean method. The results imply that a fully efficient sub-sector doesn't exist in wood and wood based products manufacturing industries, but there are some sub-sectors that outperform other sub-sectors. In the highly efficient range, there are laminboard, particle board and other panels board, veneer sheets and plywood with the mean value of technical efficiency of 1.097 and 1.081 respectively. The laminboard, particle board and other panels and board industry achieves the highest technical efficiency followed by veneer sheets which match our expectation due to both sub-sector industries meet the international standards.

In term of SE specification, the mean value of scale efficiency generally is between 1.0252 and 1.1956 which implies that, on the overall, none of the subsector is fully scale efficient though fully scale efficient individual firms in the sub-sector may exist. The diseconomy of scale varies among the sectors. The sub-sectors in the high scale efficient range are veneer sheets and plywood and laminboard, particle board and other panels and board industries with the mean value of scale efficiency of 1.0252 and 1.0310 respectively.

In the CRS specification results, the standard deviation value is between 0.1195 and 0.9209, whereas in the VRS specification results, there are standard deviation value is between 0.1030 and 0.8859. In both specifications, the sawmilling and planing of wood is the highest spread industry followed by builders' carpentry and joinery, wooden and cane furniture, wooden and cane containers, veneer sheets and plywood and laminboard, particle board and other panels and board. In term of SE, the results are consistent with the mean value results as below, where the mean value in SE is smaller compare to CRS and VRS specifications, and then the standard deviation in SE is smaller compare to CRS and VRS specifications. The results above imply that the highly efficient sub-sector industries in wood and wood based products industry typically will be achieve the lowest spread. This is mainly because the highly efficient sub-sector industries will be able to effectively control the firms' productions.

4.02 Returns to scale

Table 3 of appendix below reports the nature of the returns to scale of the firms of wood products industry. An increasing returns to scale (IRS) characteristic indicates that a firm could improve its efficiency by scaling up its activities. A decreasing returns to scale (DRS) characteristic indicates that a firm could improve its efficiency by scaling down its activities. A constant returns to scale (CRS) characteristic shows that the firm already operates at its optimal scale and its inefficiency, if any, is due to technical inefficiency and cannot be improved by simply scaling up or down its activities. In the wood and wood products industry, economies of scale varied between the firms in the sub-sectors. The majority of the firms industries were operating at DRS in the following: wooden and cane furniture (85.30%), builders' carpentry and joinery (75.72%), wooden and cane containers (62.50%), sawmilling and planing of wood (60.80%), and veneer sheets and plywood (57.98%) respectively. In contrast, the majority of firms in the laminboard, particle board and other panels and board (47.27%) industry were operating at CRS. The firms operating at DRS should be split into smaller units and partition the operation into specialized function in order to make the firms to be more efficient in terms of utilization of inputs.

4.03 Technical efficiency in Malaysian manufacturing industries based on 5 digits MSIC code

Table 4 of appendix below reports the technical efficiency of various (155) industries in 2005 for DEA and DEA-BSC model based on Malaysian Manufacturing Industries 5 digits MSIC code. We found that the DEA-BSC score will be equals to or smaller than the DEA scores. This is because problems related to discrimination between efficient and inefficient decision-making units often arise, particularly if there are a relatively large number of variables with respect to observations.

The results show that there are no efficient industries using the DEA model, however, there are four efficient industries using the extended DEA-BSC model. These industries are the brooms, brushes and mops (36991), carpets and rugs (17220), medical and surgical equipment and orthopaedic appliances (33110) and other articles of paper and paperboard (21099). Some of the industries were strong performers although they were not fully efficient. These industries can be referred to as near efficient industries which achieved a score between 1 and 1.05. With the DEA-BSC model, there are 41 near efficient industries. These are processing and preserving of poultry (15111), manufacture of electronic power cables and wires (31302), recycling of other non-metal waste and scrap (37209), etc. Of these industries, 2 industries are also regarded to be near efficient under the DEA model which is the manufacture of palm kernel oil (15144) and manufacture of glucose, glucose syrup, maltose and manufacture of other starch products(15323 & 15329). This enhances the confidence of the results for these two industries.

Table 5 of appendix below shows the distribution of DEA and DEA-BCS technical efficiency scores in Malaysian Manufacturing Industries. There are some differences between the distribution of DEA and DEA-BSC technical efficiency scores. This is because when the number of variables included increases in the DEA-BSC model, the number of efficient firms is expected to increase and hence the scores of technical efficiency in each industries increase as well. In the DEA model, the range of technical efficiency for the majority of the Malaysian Manufacturing Industries is between 1.11 and 1.4 that comprised 63.88 percent of the distribution, but in DEA-BSC model, the technical efficiency of the industries range between 1.11 and 1.4 that only comprised 41.29 percent of the distribution. Despite that, in the DEA-BSC model, the range of technical efficiency for the majority of the Malaysian Manufacturing Industries is between 1.01 and 1.2 that comprised 81.93 percent of the distribution. This is mainly because the DEA-BSC model has 7 variables compare to DEA model has only 3 variables. Besides that, there are 67 industries (43.22%) performed poorly with a score above 1.3 in DEA model, but only 12 industries (7.76%) performed poorly with a score above 1.3 in DEA-BSC model. Nevertheless, the distribution of DEA and DEA-BCS technical efficiency in Malaysian Manufacturing Industries shows that some of the industries have the scores of technical efficiency below 1.05. These are 3 industries (1.94%) in DEA model and 45 industries (29.03%) in DEA-BSC model were operating at or near to the most optimal productions.

4.04 Technical efficiency in Malaysian manufacturing industries based on 3 digits MSIC code

There are no fully efficient industries using the DEA and DEA-BSC model since none of the industry had a score of unity. Some of the industries were strong performers although they were not fully efficient. These industries can be referred to as near efficient industries which achieved a score between 1 and 1.05. With the DEA-BSC model, there are 7 near efficient industries. These are manufacture of motor vehicles (341), optical instruments and photographic equipment (332), recycling of other non-metal waste and scrap (372), dairy products (152), domestic appliances (293) and tin smelting & manufacture of other basic precious and other non-ferrous metals (272). However of these industries, none of them were also regarded to be near efficient under the DEA model. The top performer is the manufacture of motor vehicles (341) with an average efficiency score of 1.02. this is followed by the manufacture of optical instruments and photographic equipment (332) with an average efficiency score of 1.02, recycling of other non-metal waste and scrap (372) with an average efficiency score of 1.02, dairy products (152) with an average efficiency score of 1.04, domestic appliances (293) with an average efficiency score of 1.05 and tin smelting & manufacture of other basic precious and other non-ferrous metals (272) with an average efficiency score of 1.05. Using the DEA-BSC model, as many as 20 industries performed poorly with a score of 1.3 and above.

In fact, the majority of the industries in the Malaysian Manufacturing Industries in the DEA model have a technical efficiency level above 1.41, there are 30 industries which comprise 56.6 percent of the industry. Only 15 industries (43.39%) have a technical efficiency score in the range of 1.11 and 1.4. On the other hand, in DEA-BSC model, there are 10 industries (18.87%) that performed poorly with a score above 1.4 in DEA model. The distribution of DEA and DEA-BCS technical efficiency in Malaysian Manufacturing Industries show that most of the industries have the average technical efficiency scores below 1.05 with only 7 industries (13.21%) in DEA-BSC model operating at or near to the most optimal productions. This shows that there is huge potential for improvement in most of the manufacturing industries in Malaysia.

4.05 Determinants of technical efficiency of Malaysian manufacturing industries based on 3 digits MSIC code

Some of independent variables do not have any or too few data based on the Malaysian Standard Industry Classification (MSIC) at 3 digits level and hence there have no details of the variables is this analysis. Besides that, a preliminary analysis reveals that there is multicollinearity between the independent variables. It could be argued that these variables may measure the same phenomenon; therefore some of variables are not included into the model.

It is important to note that the dependent variables in the model are the inefficiency, thus the sign of the coefficients are reversed. A positive coefficient implies an inefficiency increase whereas a negative coefficient means an association with inefficiency decline or increased efficiency. Besides that, only the results of the variables in the Tobit model are significant at 95% level or higher are discussed in this analysis. The discussion will be based on the factors.

a) *Export*

The export variable has negative statistically significant coefficient in the Tobit model of production, processing and preserving of meat, fish, vegetables, oils and fats (151) and general-purpose machinery (291). The sign of the export variable is negative as expected in all the industries and hence increase in the export can increase the firms' efficiency.

b) Import of raw material

The import of raw material is only negative statistically significant in the Tobit model of special purpose machinery (292). The sign of the import of raw material variable is negative as expected in all the industries, therefore increasing in the import of raw material can increase the firms' efficiency.

c) Industrial state

The industrial state (IND) variables has statistically significant coefficient in Tobit model of production, processing and preserving of meat, fish, vegetables, oils and fats (151), biscuit, cookies, bread, cake and other bakery products (154a), tobacco products (160), spinning, weaving and finishing of textiles (171), publishing (222), basic chemicals (241), plastic products (252), non-metallic mineral products (269), other fabricated metal products; metal working service activities (289), special purpose machinery (292), insulated wires and cables (313), electric lighting equipment (315) and manufacturing (369). However but the signs of the coefficient are mixed, thus it is hard to decide the effect of the industrial state to the industries due to the firms. Furthermore we should be looking at the marginal effects compare to the constant the IND variable is a dummy variable. The marginal effects are statistically negative which when a factory locate in the industrial state will increase the firms' efficiency or the marginal effects are statistically positive which when a factory locate in the industrial state will decrease the firms' efficiency. This is because the industrial states provide better infrastructure and opportunities to firms to improve products quality, but some of the industrial states are far from the customer and resource market.

d) Firms' oversea investment

In the Tobit model of plastic products (252), the firms' oversea investment variable is positive statistically significant. This is because small and medium firms comprise of more than 90 per cent of the total manufacturing establishments in Malaysia. Even though the global competitiveness of the manufacturing industry is greatly supported, the small and medium firms are incapable to invest due to lack of fund and skilled worker. The firms undertake overseas investments due to tax deferrals that are less productive (Brumbaugh, 2006).

e) Advertising and promotional expenses

The advertising and promotional expenses is negative statistically significant in the Tobit model of special purpose machinery (292). The negative sign of the advertising and promotional expenses variable is as expected in all industries which may indicate that increasing advertising and promotional expenses may increase the firms' efficiency.

f) Staff

On the other hand, the staff variable has statistically significant positive coefficient in Tobit model of production, processing and preserving of meat, fish, vegetables, oils and fats (151), grain mill products, starches and starch products and prepared animal feeds (153), products of wood, cork, straw and plaiting materials (202), other chemical products (242), rubber products (251), plastic products (252), tanks, reservoirs and steam generators (281), general-purpose machinery (291), special purpose machinery (292), furniture (361) and manufacturing (369). As a result of more than 90% of manufacturing sector comprises by small and medium firms, the positive sign of the number of staff is matched with our expectation in all the industries, which may indicate that firms should reduce the staffs, but increase the automation of production process to increase the efficiency. Nevertheless, the staffs could be increase proportional to other inputs such as machine, land and so on and the staffs have the right tools to increase the firms' efficiency.

g) Staff training cost

Only in Tobit model of structural metal products, tanks, reservoirs and steam generators (281), the staff training cost has statistically significant negative coefficient. This result may reveal that increasing staff training cost can increase the efficiency.

4.06 Determinant of technical efficiency of wood and wood based products industries

In the table 6 of appendix above shows the EPURCH independent variables does not has data based on the wood and wood based products industry and hence the variable is excluded from the Tobit model. A preliminary analysis reveals that there is multicollinearity between the independent variables of EXPORT and STAFF with the correlation is 0.8. It could be argued that these variables may measure the same phenomenon; therefore the STAFF variable is e not included into the model.

The estimation for the Tobit model of the wood and wood based products is summarized in table 7 below the export variable is only statistically significant negative in the Tobit model of wood and wood based products industry. The sign of the export variable is negative as expected in all the Tobit model and hence increase in the export can increase the firms' efficiency. The industrial state (IND) variable has only statistically significant positive coefficient in Tobit model of wood and wood based products industry. As a result of the IND variable is a dummy variable, therefore we should be looking at the marginal effects compare to the constant. The marginal effects are statistically negative which when a factory locate in the industrial state will reduce the firms'

efficiency. This is because the industrial states are Johor, Penang and Selangor which are far from the wood resources. In the Tobit model of wood and wood based products industry, the firms’ overseas investment variable is negative statistically significant. The sign of the coefficient is negative which implies increasing in firms’ overseas investment mixed can increase the firms’ efficiency.

Table 7: Tobit regression coefficient estimates of the DEA-BSC-VRS scores of the 3 digits MSIC code industry

wood and wood based products industry				
Independent variables	Coefficient	Std. Error	z-Statistic	Prob.
Constant	0.986044	0.021392	46.09493	0**
EPURCH				
ESALE	-5.21E-08	3.89E-08	-1.33869	0.1807
EXPORT	-3.76E-09	8.65E-10	-4.33908	0**
IMPPAC	2.79E-07	9.70E-07	0.288142	0.7732
IMPRAW	8.85E-10	4.83E-09	0.183166	0.8547
IND	6.02E-01	7.69E-02	7.829727	0**
INVESTOS	-0.61101	0.134868	-4.53044	0**
PATEN	-5.84E-07	1.38E-06	-0.42278	0.6725
PROMO	9.47E-08	1.61E-07	0.586859	0.5573
RD	-1.32E-07	4.44E-07	-0.29665	0.7667
STAFF				
TECHEXP	-1.06E-06	7.67E-07	-1.37647	0.1687
TRAINING	-8.73E-08	3.89E-07	-0.22446	0.8224

** Significant at 0.01 level

5.0 Conclusions

In general, the majority of the firms in the wood and wood based products industry are operating inefficiently but there are only two sub-sector industries that have more than 50% firms, who are operating efficiently. Therefore the firms are encouraged to obtain international certifications which would promote the ‘green’ image of the industry through sustainable foreign management.

However the veneer sheets and plywood and laminboard, particle board and other panels and board sub sectors have higher scale efficiency than technical efficiency; this means that global inefficiencies are mainly attributed to inefficient operations or management. Thus, in these sub-sector industries, the firms should promote the efficient and effective management of wood resources.

The results from this study show that the determinants of level of firms’ efficiency in the wood and wood based products industry are the firm’s factory location in the industrial state, level of exports and firms’ overseas investment. However, the variable of the firm’s factory location in the industrial state explains negatively the level of firms’ efficiency in the wood and wood based products industry. Therefore the agro-forestry activities should be encouraged to provide intermediate returns to sustain the viability of forest plantation projects.

The firms’ overseas investment is a positively significant determinant of efficiency for the firms in the wood and wood based products industry. The industry seems has a greater incentive to outsource logs and other semi-finished components through outward investments in resource rich countries in order to get extra market share and profits. In addition, the export is also a positively significant determinant for the firms in the wood and wood based products industry. Since export will increase the firms’ efficiency and profitability, efforts should be intensified to gain access to non-traditional markets such as India, West Asia and Africa.

6.0 Recommendation and strategies of the Malaysian manufacturing industry

The results of technical efficiency in DEA-BSC model in the 3 and 5 digits MSIC code analysis for Malaysian Manufacturing Industries are consistent with each other; generally the majority of the firms in the Malaysian manufacturing industry based on 5 digits or 3 digits MSIC code are operating technical inefficiently. Therefore the firms should optimize its utilization of its resources in order to reduce the cost of production as well as achieve a higher competitive edge.

The results from this study show the determinants of level of efficiency are different by industries. The firms in light and medium industries should focus on their core competencies and strengths within the regional and global networks in order to increase its export. The import of raw material contributes positively to firms’ efficiency especially for special purpose machinery industry which can be categorized as a medium industry.

Thus the firms should import some non-core products in order to remain competitive, lower the production costs and increase the efficiency. Additionally advertising and promotional expenses contributes positively to firms' efficiency especially for medium industries. The firms of medium industries should increase its advertising and promotional expenses to develop and promote its products brand in order to expand the operations in Malaysia.

Even though the firm's factory location in industrial states significantly influence the firms' efficiency, its effect is hard to decide. Its relationship is positive for light industries. However its relationship is negative for resource-based industries. Therefore the government need to develop the cluster near to the resources as well as the clusters must be supported with the required workforce. The number of staff is found to be significant determinants of firms' efficiency, but it is negatively significant for resource-based industries. This may be due to more than 90% of manufacturing sector comprises of small and medium firms which are labour intensive and generally lack of fund, thus the firms to increase the utilization of automated equipment and machinery to reduce the dependency of labour while attaining higher efficiency and productivity.

The staff training cost is a positively significant determinant of efficiency for the firms of structural metal products, tanks, reservoirs and steam generators industry which can be categorized in heavy industries. Owing to move towards a more knowledge-based operating environment, the firms should emphasize and conduct on a higher level of creativity, innovation and other enabling skills in training systems to improve the employees' skills as well as increase the firms' efficiency and performance.

Finally, it is important for the government and the manufacturing sector to understand the strengths and weaknesses in order to develop and promote the Malaysian brands and enhancing exports through in order to improve the firm's efficiency and productivity whilst make enhancing Malaysia's position as a major trading nation.

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APPENDIX

Table 1: Distribution of technical efficiency of industry of wood and wood based products

Range of efficiency/ industry	Technical efficiency (CRS)		Pure Technical efficiency (VRS)		Scale efficiency (SE)	
	Frequency	(%)	Frequency	(%)	Frequency	(%)
Sawmilling and planing of wood						
1	36	(6.27)	63	(10.98)	115	(20.03)
1.01-1.1	7	(1.22)	10	(1.74)	193	(33.62)
1.11-1.2	9	(1.57)	18	(3.14)	64	(11.15)
1.21-1.3	4	(0.70)	13	(2.26)	50	(8.71)
1.31-1.4	10	(1.74)	16	(2.79)	32	(5.57)
>1.41	508	(88.50)	454	(79.09)	120	(20.91)
Total	574	(100)	574	(100)	574	(100)
Veneer sheets and plywood						
1	35	(29.41)	59	(49.58)	48	(40.34)
1.01-1.1	31	(26.05)	19	(15.97)	63	(52.94)
1.11-1.2	32	(26.89)	28	(23.53)	7	(5.88)
1.21-1.3	16	(13.45)	8	(6.72)	1	(0.84)
1.31-1.4	2	(1.68)	2	(1.68)	0	(0.00)
>1.41	3	(2.52)	3	(2.52)	0	(0.00)
Total	119	(100)	119	(100)	119	(100)
Laminboard, particle board and other panels and board						
1	26	(47.27)	33	(60.00)	36	(65.45)
1.01-1.1	5	(9.09)	5	(9.09)	13	(23.64)
1.11-1.2	12	(21.82)	10	(18.18)	4	(7.27)
1.21-1.3	7	(12.73)	5	(9.09)	1	(1.82)
1.31-1.4	5	(9.09)	2	(3.64)	1	(1.82)
>1.41	0	(0.00)	0	(0.00)	0	(0.00)
Total	55	(100)	55	(100)	55	(100)
Builders' carpentry and joinery						
1	23	(9.47)	73	(30.04)	29	(11.93)
1.01-1.1	6	(2.47)	20	(8.23)	42	(17.28)
1.11-1.2	6	(2.47)	31	(12.76)	22	(9.05)
1.21-1.3	8	(3.29)	25	(10.29)	19	(7.82)
1.31-1.4	11	(4.53)	16	(6.58)	23	(9.47)
>1.41	189	(77.78)	78	(32.10)	108	(44.44)
Total	243	(100)	243	(100)	243	(100)
Wooden and cane containers						
1	19	(26.39)	31	(43.06)	24	(33.33)
1.01-1.1	5	(6.94)	11	(15.28)	15	(20.83)
1.11-1.2	7	(9.72)	10	(13.89)	9	(12.50)
1.21-1.3	8	(11.11)	9	(12.50)	9	(12.50)
1.31-1.4	6	(8.33)	4	(5.56)	8	(11.11)
>1.41	27	(37.50)	7	(9.72)	7	(9.72)
Total	72	(100)	72	(100)	72	(100)
Wooden and cane furniture						
1	55	(6.12)	161	(17.93)	73	(8.13)
1.01-1.1	28	(3.12)	97	(10.80)	155	(17.26)
1.11-1.2	27	(3.01)	116	(12.92)	83	(9.24)
1.21-1.3	44	(4.90)	111	(12.36)	89	(9.91)
1.31-1.4	34	(3.79)	110	(12.25)	79	(8.80)
>1.41	710	(79.06)	303	(33.74)	419	(46.66)
Total	898	(100)	898	(100)	898	(100)

Table 2: Descriptive statistics of firms' technical efficiency by industry

Technical efficiency	CRS	VRS	Scale
Sawmilling and planing of wood			
Minimum value	1.0000	1.0000	1.0000
Maximum value	7.3098	5.2290	3.3870
Mean value	2.5041	2.0944	1.1956
Standard deviation	0.9209	0.8859	0.3393
Veneer sheets and plywood			
Minimum value	1.0000	1.0000	1.0000
Maximum value	1.6545	1.5622	1.2421
Mean value	1.0981	1.0710	1.0252
Standard deviation	0.1214	0.1112	0.0425
Laminboard, particle board and other panels and board			
Minimum value	1.0000	1.0000	1.0000
Maximum value	1.3793	1.3379	1.3793
Mean value	1.0970	1.0640	1.0310
Standard deviation	0.1195	0.1030	0.0687
Builders' carpentry and joinery			
Minimum value	1.0000	1.0000	1.0000
Maximum value	4.1194	3.4060	2.9516
Mean value	1.8587	1.3075	1.4216
Standard deviation	0.7251	0.4917	0.4970
Wooden and cane containers			
Minimum value	1.0000	1.0000	1.0000
Maximum value	3.1263	2.3253	2.1929
Mean value	1.3234	1.1368	1.1641
Standard deviation	0.4281	0.2611	0.2640
Wooden and cane furniture			
Minimum value	1.0000	1.0000	1.0000
Maximum value	3.7353	3.0755	3.0666
Mean value	1.8005	1.2994	1.3856
Standard deviation	0.5093	0.3181	0.3604
Industry Average	1.5404	1.2901	1.1940

Table 3: Technical efficiency of industry of wood products

Returns to scale/ Industry	CRS		IRS		DRS		Total
	Frequency	%	Frequency	%	Frequency	%	
Sawmilling and planing of wood	38	6.62	187	32.58	349	60.80	574
Veneer sheets and plywood	35	29.41	15	12.61	69	57.98	119
Laminboard, particle board and other panels and board	26	47.27	7	12.73	22	40.00	55
Builders' carpentry and joinery	24	9.88	35	14.40	184	75.72	243
Wooden and cane containers	20	27.78	7	9.72	45	62.50	72
Wooden and cane furniture	55	6.12	77	8.57	766	85.30	898
Total	198	10.1	328	16.72	1435	73.18	1961

Table 4: Technical efficiency of Malaysian Manufacturing Industries (5 digits MSIC code) for DEA and DEA-BSC model

MSIC Code	Description	Number of Firms	DEA Score	DEA-BSC Score	MSIC Code	Description	Number of Firms	DEA Score	DEA-BSC Score
15111	Processing and preserving of poultry and poultry products	21	1.10	1.01	25191	Rubber remilling and latex processing	89	1.23	1.07
15119	Production, processing and preserving of other meat and meat products	37	1.13	1.02	25193	Manufacture of rubber gloves	80	1.37	1.12
15120	Processing and preserving of fish	192	2.01	1.26	25199	Manufacture of other rubber products	198	1.44	1.19

	and fish products Canning and preserving of other fruits and vegetables	41	1.19	1.06	25201	Manufacture of plastic blow moulded products	177	1.32	1.15
15139	Manufacture of coconut oil	15	1.09	1.02	25202	Manufacture of plastic extruded products	69	1.49	1.16
15141	Manufacture of crude palm oil	327	1.28	1.20	25203	Manufacture of plastic bags and firms	263	1.47	1.17
15142	Manufacture of refined palm oil	32	1.08	1.02	25205	Manufacture of plastic foam products	44	1.16	1.08
15143	Manufacture of palm kernel oil	34	1.05	1.01	25206	Manufacture of plastic injection moulded products and components	249	1.55	1.27
15144	Manufacture of other vegetable and animal oils and fats	43	1.27	1.07	25209	Manufacture of other plastic products	394	2.98	1.99
15149	Manufacture of ice cream	28	1.10	1.02	26100	Manufacture of glass and glass products	147	1.34	1.17
15201	Manufacture of condensed, powdered and evaporated milk and manufacture of other dairy products	14	1.10	1.03	26910	Manufacture of non- structural and non- refractory ceramic ware	77	1.32	1.09
15202& 15209	Rice milling	174	1.19	1.08	26920	Manufacture of refractory ceramic products	104	1.46	1.14
15311	Flour milling	17	1.18	1.07	26930	Manufacture of non- refractory clay and ceramic products	90	1.64	1.20
15312	Manufacture of glucose, glucose syrup, maltose and manufacture of other starch products	20	1.04	1.02	26941	Manufacture of hydraulic cement	25	1.14	1.04
15323& 15329	Manufacture of prepared animal feeds	74	1.29	1.08	26942	Manufacture of lime and plaster	34	1.31	1.05
15330	Manufacture of biscuits and cookies	121	1.33	1.14	26951	Manufacture of ready- mix concrete	99	1.21	1.09
15411	Manufacture of bread, cakes and other bakery products	632	2.25	1.73	26959	Manufacture of other articles of concrete, cement and plaster	249	1.49	1.16
15412	Manufacture of cocoa products	15	1.10	1.01	26960	Cutting, shaping and finishing of stone	54	1.24	1.05
15431	Manufacture of chocolate and chocolate products	39	1.19	1.05	26990	Manufacture of other non-metallic mineral products	90	1.42	1.15
15432	Manufacture of macaroni, noodles and similar products	202	1.28	1.16	27100	Manufacture of basic iron and steel products	360	2.52	1.70
15440	Manufacture of ice(excluding dry ice)	110	1.31	1.14	27201& 27209	Tin smelting & manufacture of other basic precious and other non-ferrous metals	102	1.16	1.05
15491	Manufacture of coffee	104	1.22	1.06	27310	Casting of iron and steel	226	1.34	1.16
15492	Manufacture of spices and curry powder	65	1.11	1.03	27320	Casting of non-ferrous metals	29	1.14	1.02
15494	Manufacture of nut	22	1.10	1.01	28110	Manufacture of	952	1.70	1.32
15495									

	and nut products					structural metal products			
15496	Manufacture of sauces including flavouring extracts such as monosodium glutamate	94	1.29	1.17	28120	Manufacture of tanks, reservoirs and containers of metal	57	1.29	1.13
15497	Manufacture of snack:cracker/chips	163	1.35	1.16	28910	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	177	1.23	1.10
15499	Manufacture of other food products	195	1.38	1.24	28920	Treatment and coating of metals, general mechanical engineering on a fee or contract basis	72	1.31	1.08
15510	Distilling, rectifying and blending of spirits; ethyl alcohol production from fermented materials	25	1.20	1.03	28930	Manufacture of cutlery, hand tools and general hardware	53	1.19	1.07
15541	Manufacture of soft drinks	87	1.39	1.11	28991	Manufacture of tin cans and metal boxes	57	1.36	1.06
15542	Production of mineral water	31	1.30	1.06	28992	Manufacture of wire, wire products and metal fasteners	198	1.32	1.16
16000	Manufacture of tobacco products	163	1.40	1.24	28993	Manufacture of brass, copper, pewter and aluminium products	165	1.41	1.14
17111	Natural fibre spinning; weaving of textiles	33	1.17	1.04	28999	Manufacture of other fabricated metal products	162	2.03	1.33
17112	Man-made fibre spinning; weaving of textiles	27	1.12	1.03	29120	Manufacture of pumps, compressors, taps and valves	37	1.19	1.05
17121	Dyeing, bleaching, printing and finishing of yarns and fabrics	45	1.10	1.04	29130	Manufacture of bearings, gears, gearing and driving elements	31	1.23	1.03
17122	Batik making	71	1.50	1.25	29150	Manufacture of lifting and handling equipment	36	1.21	1.07
17210	Manufacture of made-up textile articles except apparel	108	1.25	1.11	29191	Manufacture of air-conditioning, refrigerating and ventilating machinery	92	1.30	1.06
17220	Manufacture of carpets and rugs	15	1.07	1.00	29199	Manufacture of other general-purpose machinery	110	1.51	1.15
17291	Handicraft spinning and weaving	24	1.10	1.01	29210	Manufacture of agricultural and forestry machinery	64	1.30	1.15
17299	Manufacture of other textiles	46	1.58	1.07	29220	Manufacture of machine tools	304	1.50	1.26
17300	Manufacture of knitted and crocheted fabrics and articles	84	1.55	1.21	29240	Manufacture of machinery for mining, quarrying and construction	41	1.14	1.06
18101	Manufacture of clothings	452	1.64	1.25	29250	Manufacture of machinery for food, beverage and tobacco processing	23	1.12	1.01
18102	Custom tailoring and dressmaking	634	2.04	1.49	29270&29290	Manufacture of weapons and ammunition and manufacture of other	80	1.22	1.15

						special-purpose machinery			
18109&18200	Manufacture of miscellaneous wearing apparel and dressing and dyeing of fur; Manufacture of article of fur	42	1.28	1.08	29300	Manufacture of domestic appliances	47	1.15	1.05
19120	Manufacture of luggage, handbags and the like, saddlery and harness of leather and leather substitutes	47	1.23	1.06	30002	Manufacture of computers and computer peripherals	59	1.33	1.12
19200	Manufacture of footwear	168	2.26	1.48	31100	Manufacture of electric motors, generators and transformers	58	1.29	1.06
20100	Sawmilling and planing of wood	574	2.97	2.09	31200	Manufacture of electricity distribution and control apparatus	117	1.40	1.13
20211	Manufacture of veneer sheets and plywood	119	1.16	1.07	31301	Manufacture of telecommunication cables and wires	20	1.16	1.03
20212	Manufacture of laminboard, particle board and other panels and board	55	1.17	1.06	31302	Manufacture of electronic power cables and wires	24	1.09	1.01
20220	Manufacture of builders' carpentry and joinery	243	1.63	1.31	31309	Manufacture of other insulated wires and cables	76	1.18	1.07
20230	Manufacture of wooden and cane containers	72	1.32	1.14	31400	Manufacture of accumulators, primary cells and primary batteries	20	1.23	1.05
20291	Manufacture of wood charcoal	35	1.27	1.07	31500	Manufacture of electric lighting equipment	41	1.27	1.07
20299	Manufacture of other products of wood, cane, articles of cork, straw and plaiting materials	115	1.34	1.13	31900	Manufacture of other electric equipment	78	1.29	1.11
21010	Manufacture of pulp, paper and paperboard	99	1.20	1.09	32101	Manufacture of semi-conductor devices	86	1.95	1.18
21020	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	205	1.57	1.18	32102	Manufacture of electronic valves and tubes and printed circuit boards	115	1.62	1.24
21092	Manufacture of envelopes, letter-card, correspondence cards or plain postcards	20	1.38	1.07	32109	Manufacture of other electronic components	58	1.26	1.11
21093	Manufacture of toilet paper, cleansing tissue, towels, serviettes	19	1.18	1.04	32200	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	31	1.19	1.08
21095	Manufacture of sanitary towels and tampons, disposable napkins	11	1.38	1.02	32300	Manufacture of television and radio receivers, sound or video recording or	121	1.37	1.17

	and napkin liners for babies					reproducing apparatus and associated goods			
21096	Manufacture of gummed or adhesive paper in strips or rolls and labels and wall paper	40	1.27	1.14	33110	Manufacture of medical and surgical equipment and orthopaedic appliances	11	1.13	1.00
21097	Manufacture of effigies, funeral paper goods, joss paper	34	1.24	1.14	33120	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	23	1.17	1.02
21099	Manufacture of other articles of paper and paperboard	23	1.12	1.00	33201	Manufacture of optical instruments	13	1.14	1.01
22110	Publishing of books, brochures, musical books, maps and other publications	115	1.56	1.31	34100	Manufacture of motor vehicles	17	1.28	1.02
22120	Publishing of newspapers, journals and periodicals	45	1.28	1.09	34200	Manufacture of bodies(coachwork) for motor vehicles; manufacture of trailers and semitrailers	69	1.36	1.13
22190	Other publishing	32	1.19	1.06	34300	Manufacture of parts and accessories of bodies for motor vehicles and their engines	160	1.42	1.20
22210	Printing	594	1.54	1.36	35110	Building and repairing of ships	119	1.44	1.15
22220	Service activities related to printing	329	1.70	1.43	35120	Building and repairing of pleasure and sporting boats	24	1.09	1.03
23100&23200	Manufacture of coke oven products and manufacture of refined petroleum products	25	1.23	1.08	35910	Manufacture of motorcycles	44	1.33	1.07
24111	Manufacture of industrial gases, whether compressed, liquefied or in solid state	41	1.79	1.25	35920	Manufacture of bicycles and invalid carriages	28	1.71	1.08
24119	Manufacture of other basic industrial chemicals except fertilizers and nitrogen compounds	89	1.39	1.12	36101	Manufacture of wooden and cane furniture	901	1.67	1.30
24120	Manufacture of fertilizers and nitrogen compounds	31	1.44	1.14	36102	Manufacture of metal furniture	125	1.22	1.08
24130	Manufacture of plastics in primary forms and of synthetic rubber	109	1.24	1.14	36109	Manufacture of other furniture except of stone, concrete or ceramic	126	1.19	1.08
24210	Manufacture of pesticides and other agrochemical products	26	1.13	1.05	36910	Manufacture of jewellery and related articles	108	1.26	1.13

24221	Manufacture of paints, varnishes and similar coatings ink and mastics	106	1.36	1.16	36930	Manufacture of sports goods	27	1.19	1.04
24222	Manufacture of printing ink	27	1.18	1.06	36940	Manufacture of games and toys	26	1.10	1.03
24230	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	118	1.46	1.21	36991	Manufacture of brooms, brushes and mops	14	1.05	1.00
24240	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	108	1.34	1.15	36992	Manufacture of pens, pencils, office and artists' supplies	43	1.17	1.04
24290	Manufacture of other chemical products	101	1.72	1.20	36999	Other manufacturing	254	1.44	1.16
25111	Manufacture of rubber tyres and tubes	26	1.19	1.05	37209	Recycling of other non-metal waste and scrap	43	1.14	1.03
25112	Retreading and rebuilding of rubber tyres	43	1.14	1.07					

Table 5: Distribution of technical efficiency in Malaysian Manufacturing Industries

Range of efficiency	DEA		DEA-BSC	
	Number of industries	(%)	Number of industries	(%)
1	0	(0.00)	4	(2.58)
1.01-1.05	3	(1.94)	41	(26.45)
1.06-1.1	13	(8.39)	39	(25.16)
1.11-1.2	38	(24.52)	47	(30.32)
1.21-1.3	34	(21.94)	12	(7.74)
1.31-1.4	27	(17.42)	5	(3.23)
1.41-1.5	14	(9.03)	3	(1.94)
1.51-2	18	(11.61)	3	(1.94)
>2	8	(5.16)	1	(0.65)
Total	155	(100.00)	155	(100.00)

Table 6: Tobit model of the DEA-BSC-CRS scores of the wood and wood based products industry

Excluded variable	Reasons
EPURCH	Data not available
STAFF	The correlation with EXPORT is 0.80.
Tobit model:	
$EFF_i = \alpha_0 + \alpha_1 ESAL E_i + \alpha_2 EXPORT_i + \alpha_3 IMPPAC_i + \alpha_4 IMPRAW_i$	
$+ \alpha_5 IND_i + \alpha_6 INVESTOS_i + \alpha_7 PATEN_i + \alpha_8 PROMQ_i$	
$+ \alpha_9 RD_i + \alpha_{10} TECHEXP_i + \alpha_{11} TRAINING_i + \alpha_{12} \varepsilon_i$	