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Stock Selection using the Data Envelopment Analysis Models and DuPont Analysis

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Abstract

Analysing performance using the financial ratio is challenging for many investors and researchers. The purpose of this study is to evaluate efficiency performance of decision-making units (DMUs) which is stocks company of using production frontier-based and accounting-based approaches. Thus, the data envelopment analysis (DEA) models and DuPont analysis were applied. Specifically, DuPont analysis was utilized to evaluate three different aspects: profitability, the efficiency of assets utilization and financial leverage. The return on equity (ROE) was calculated to rank the companies' performance. Meanwhile, the estimation method of DEA computed the efficiency scores and ranked the companies accordingly based on the ROE, return on assets, earnings per share, net profit margin, price to earnings ratio, debt to equity ratio and asset turnover. The major results showed that DMUs (company) gave different picture performance rankings with different approaches. The finding also revealed that the results from DEA method, gave more comprehensive analysis in term of efficiency measurement, whereas DuPont presented good analysis because it provided information for investors if the highest return is the main objective for them. Additionally, the analysis also provided an indication whether a company can earn a higher return if it generates a high net profit margin; if it uses its assets effectively to generate more sales and if it has a high financial leverage.

Keywords: Performance, Efficiency, Ranking, Financial Ratio, DuPont

Introduction

Consumer products can greatly affect Malaysia's economic development due to an increase in consumption. The data from January to June 2002 show the registering of an output growth of 1.7% and export value of slightly more than RM3.4 billion. The changing demographic structure towards a young population profile with 27% in the age group between 15 to 29 years old has in turn changed the consumption pattern of Malaysians. With higher per capita income, coupled with modern urban lifestyles, Malaysians' consumption of ready to serve and fast-food items have accelerated. Canned drinks, in particular carbonated drinks, surged

to almost 50% of total output of beverages. The food, beverages and tobacco industries worth more than RM5,960 million contributed to 10% of total manufacturing output, expanded appreciably to record a higher growth of 11.7% (January-June 2002: 1.2%). Various measures taken to boost consumption had also resulted in stronger domestic demand and growth in most food items, such as coconut oil, margarine, rice, as well as flour, biscuits and canned pineapples. It shows that the industry sustained its importance as one of Malaysia's major export earners. Therefore, to enhance the growth of consumer products industry, efficiency and performance of companies need to be improved. Based on this background, this study aimed to measure and compare the efficiency of DMUs of Malaysian's consumer product companies by using frontier efficiency methodologies and accounting-based approach, the DuPont analysis. The findings of this research can provide a great interest to any decision-makers, so that they can investigate the problems, identify the factors and weaknesses of companies' performance.

Determining a company's performance is a very challenging process. Generally, the performance measurement can be divided into two criteria: the financial and non-financial criteria. Non-financial criteria include production, marketing, administrative and social criteria. The financial criteria, however, normally uses financial ratios to assess the performance. Evaluating a company's performance using financial ratios has been a traditional yet powerful tool for decision-makers including business analysts, creditors, investors and financial managers. Rather than employing the total amounts observed on financial statements, these analyses were conducted using financial ratios to obtain meaningful results. Financial ratios are able to indicate the strengths and weaknesses of a company's performance and these tools are powerful in enabling stakeholders to analyse the condition of the companies' financial status. Financial ratios also provide a comparative financial status among companies within an industry or within the company itself.

Other than the benefits presented above, financial ratio also (i) measures the performance of managers for the purpose of rewards; (ii) measures the performance multi-level companies; (iii) projects the future by supplying historical information to existing or prospective investors; (iv) evaluates the financial performance of acquisitions. Financial ratios can be grouped into five types: liquidity, efficiency, leverage and profitability and market ratios. Liquidity ratio indicates an ability of a company to fulfil short-term obligations to its creditors, while efficiency ratio measures a company's effectiveness in managing its assets to generate profits. Profitability ratio measures a company's management of its assets, sales and equity. Profitability ratio can be analysed based on the company's gross profit margin, net profit margin, return on assets and return on equity. Leverage ratio measures the level of debt or borrowing by a company. The ratio can inform whether the company uses more debt financing to finance its assets and operation or equity. The commonly used leverage ratio is debt ratio, debt to equity ratio and times interest earned. The market ratio can be used to measure investors' perceptions and judgments of a company's growth potential. Earnings per share, dividend per share, dividend pay-out, price earnings and dividend yield are the common elements of the market ratio used by investors. Previously, various methodologies were implemented in order to evaluate the financial performance of companies in association with financial ratios. The methods are Balance Score Card (Sweiti & Lele, 2016), Decision Tree Approach (Delen et al., 2013), Technique for Order Preference By Similarity to Idea Solution (TOPSIS) (Bulgurcu, 2012), Analytic Hierarchy Process (AHP) (Rezaei & Ketabi, 2016), Grey

Relation Analysis (Kaya, 2016) and Clustering Approach (Lee et al., 2010). The Tobin's Q, Financial Ratio Analysis (FRA) and the DuPont analysis are traditional methods for analysing financial ratios under accounting and financial aspects that are still relevant today.

Many researchers use the traditional methods due to their simple calculation and simplicity in usage such as Muchtar et al., (2018) investigated the impact on Indonesian public companies' financial decision behaviour on firm-based and accounting-based performance (Return on Asset) and market-based performance (Tobin's Q method). A study by Poh et al (2018) investigates the financial performance of ten local banks in Malaysia using the Value Added Intellectual Confident (VAIC) method. The study determined how the VAIC method influenced the financial performance of those banks. The competitiveness of a country can be measured from improvement of productivity and efficiency of its enterprises. Therefore, evaluation and measurement of company's efficiency performances is important not only for managers but for investors as well as the government to ensure resources are fully utilized and to determine best practices as a way to improve performance and productivity. Performance of a company is not easy to define, and it is closely related to productivity and efficiency. The process of the decision-making unit (henceforth, DMU) utilizes the resources (inputs) to produce desired products or services (outputs) is called productivity ratio. The literature on performance measurement using frontier estimation has been widely used in economic studies of productivity and technical efficiency in hospital costs, airport, electric power, commercial fishing, farming, manufacturing, transportation, sewerage services, education, labour markets and a huge array of other settings.

Efficiency can be defined as the ability of the inputs to be converted to outputs production process. It can also be defined as the proficiency of producers in achieving their economic objective, such as production at minimum cost, generation of maximum revenue or maximization of profit (Murillo-Zamorano, 2004). The production frontier represents the maximum output from each input level. When the DMU operates either on the production frontier, it is called technically efficient; if it operates below the frontier, it is not technically efficient. However, if information on price and behavioural assumption is available, such as cost minimization or profit maximization; the allocative efficiency will be considered as a tool of performance measurement. There are two types of methodology in measuring the efficiency using frontier estimation techniques which are the parametric (econometric approach) and non-parametric (mathematical programming) methods. Niaki and Salmani (2016) employed the parametric method, Stochastic Frontier Analysis (SFA), conversely study by Tsolas (2013); Azadeh et al (2015) applied non-parametric methods, Data Envelopment Analysis (DEA) and Stochastic Data Envelopment Analysis (SDEA) for evaluating the company's performance.

Therefore, to provide the evidence and information for decision-makers in making a comparison of performance, the present study will contribute the existing literature by providing a list of methods for measuring the performance for both techniques, frontier efficiency-based and accounting-based performance. The rest of this paper is organized as follows. Section 2 reviews the literature on the DEA method and DuPont analysis. Section 3 and Section 4 describe the methodology and empirical results respectively and the final section presents the overall conclusion of this research analysis and suggestions for future studies.

Literature Review

The DEA method is a non-parametric approach that has been widely employed in a variety of disciplines as an efficiency performance measurement tool for comparing a set of DMU entities such as firms (Arsad et al., 2017), bank industry (Jha et al., 2013) and investments (Lin & Yang, 2014). These DMUs utilize the asset of multiple homogenous inputs to produce a set of multiple homogenous outputs. The concept of frontier analysis is introduced by Farrell (1957), who formed the basic DEA, but linear programming formulation and extensions were triggered by the article from (Charnes et al., 1978). In DEA, neither specific functional relationship between production outputs and inputs nor any specific statistical distribution of the error terms is assumed. Thus, DEA provides no statistical information on the goodness and reliability results. However, its ability to handle multiple inputs and outputs makes it an appealing choice and it outweighs its statistical shortcomings. DEA provides detailed information on the comparative performance of each DMU in the form of an efficiency score (one for efficient DMU and less than one for inefficient DMUs) which in this study is interpreted as a measurement of company's performance. For the inefficient DMU, DEA identifies its peers for non-performing companies from a set of efficient units. DEA also identifies improvements in output and/or input levels required by the unit to be on the efficient frontier. Peers are efficient units that could act as models for inefficient units to improve performance. In other words, DEA provides the inefficient unit with guidance or path to the frontier (Murillo-Zamorano, 2004).

The DuPont analysis is a traditional measurement of financial performance. Specifically, it uses Return on Equity (henceforth, ROE) to measure the percentage of earnings available to stockholders as per their total equity invested. It also uses return on assets as part of the calculation. Even though it is developed in the early 1900s, the application of this method is still widely applicable (Sheela, 2020). The DuPont analysis is different from the common calculation of ROE because the DuPont formula shows the relationship between profitability (net profit margin), efficiency (total assets turnover) and financial leverage (debt ratio) in determining the ROE. This means a company can use DuPont to identify factors that cause the company's low ROE. In addition to that, DuPont also emphasizes on return on assets, which is derived from multiplying the net profit margin with the total assets turnover. Return on assets can be used to measure the efficiency of assets utilization in generating profits for common stockholders. A company with the highest value of ROE is considered as a well-performed company due to the company's ability in generating a high return on stockholders' investments. A company's goal to maximize profit is also to benefit the owners or stockholders. One of the advantages of the DuPont analysis is that it allows a company to break the ROE into profits of sales (net profit margin), the effect of assets management (assets turnovers) and debt management (leverage).

Due to the advantages of the DEA method, many researchers practice it to evaluate performance in order to make decisions and improvement for the selection of stock companies such as the information technology (IT) companies in Turkey (Sengul & Eren, 2014) and cement industry in Tehran stock market (Mansouri et al., 2014). A study by Chen (2008) adopted the DEA method to construct portfolios and compare their return rates with the market index, to examine whether the DEA portfolios created superior returns from eight major industries represented on the Taiwan stock exchange market. There are also several studies applied the DEA method on Malaysian stock market performance in term of financial

ratio. One of it is a study by Mohamad and Said (2010) that measures and assesses the performance of 100 largest listed companies. Zohdi et al (2012) used DEA for evaluation of the performance of Iranian investment companies using financial statement analysis. Four different versions of DEA were applied for efficiency analysis and AP-DEA was applied for ranking of twelve considered companies. Ten different financial ratios were considered as inputs and outputs for each decision-making unit. The beta index or systematic risk, sigma index or unsystematic risk, price/earnings ratio (P/E), return on owners' equity and total assets were considered as inputs, while earnings per share (EPS), sales growth, current ratio, quick ratio, and net income were considered as outputs. Zamani et al (2014) used three inputs and four outputs to evaluate stock selection on the market of Mumbai Stock Exchange. The inputs were beta, modified 5-year beta and debt to equity ratio and the outputs were ROE, return on capital employment (ROCE), net profit margin and earning per share.

Research by Ling and Kamil (2010) applied DEA to measure the efficiency of 20 companies listed in Bursa Malaysia and they believed that only good financial performer gave a good return to the investors in the long run. The study combined all the critical criteria in evaluating the performance of the companies in term of financial performance. There were 2 portions included in the study. First, absolute amount that represented the financial status of the companies which were used to be the variables in the study. It included the total assets, current assets, current liabilities, total expenses, net income after taxes and revenue. The second portion was where the financial ratios were treated as the inputs and outputs. The DuPont analysis is still used widely in furniture industry (Burja & Marginean, 2014), bank industry (Almazari, 2012); mining sector (Kijewska, 2016); health care industry (Chang et al., 2014) and market participants (Soliman, 2008). The DuPont analysis is a potentially helpful tool for analysis that investors can use to make more informed choices regarding their equity holdings. The primary advantage of the DuPont analysis is the fuller picture of a company's overall financial health and performance that it provides, compared to more limited equity valuation tools. This current study compares performance using the DuPont analysis and DEA models (DEA-CCR model and DEA-BCC model). The aim of this study is to measure and analyse the performance stocks companies based on the financial ratio. Then, this study identifies the correlation rankings among three approaches. For ranking using the DEA-BCC and DEA-CCR models, Alirezaee and Afharian's ranking technique (Alirezaee & Afsharian, 2007) is used to rank the stocks completely. This study also identifies peer groups which act as benchmarks for non-performing companies.

Methodology

This paper employed the DEA and DuPont methods in analysing performance of cross-sectional samples data of companies' consumer product industry. This study used three different approaches to evaluate companies' performance. The two models in DEA that were applied are DEA-CCR and DEA-BCC. The ranking results of this study were compared with the DuPont analysis.

Selection of Input Output Variables

The selection of inputs and outputs for this study were based on previous studies as well as the Fuzzy Delphi Method (FDM) survey technique. Delphi method is an interactive method used to survey and collect the most reliable consensus opinions of a group of experts on a particular subject. To determine the most important financial ratios for stock evaluation, the

ratios were firstly identified from a review of the existing literature. Twenty financial ratios were chosen based on their popularity and relevance to the assessment of stock performance. The selected financial ratios were categorized into five groups' perspective, namely liquidity, profitability, leverage, asset turnover ratios and growth ratios. They distributed 14 questionnaires to experts who were working at investment companies, brokerage companies and also academicians to obtain their opinions about the importance of the criteria. Six inputs and two outputs of this study were selected by referring to the studies of Mokhtar et al., (2014) and Powers and McMullen, (2000) as shown in Table 1.

Table 1
Variables for Input and Output

Variables		Value symbol	Weight symbol
Return on equity	output	y_1	u_1
Return on assets	output	y_2	u_2
Earnings per share	output	y_3	u_3
Operating profit margin	output	y_4	u_4
Net profit margin	output	y_5	u_5
Price to earnings ratio	output	y_6	u_6
Debt to equity ratio	input	x_1	v_1
Assets turnover	input	x_2	v_2

Table 2
List of DMUs

DMU	Companies	DMU	Companies	DMU	Companies
1	Acoustech Bhd	40	Hong Leong Bhd	79	Pelangi Publishing
2	Ajinomoto Malaysia	41	Hovid Berhad	80	Pelikan Int'l Corp
3	Amtek Holdings Bhd	42	Hume Industr Bhd	81	Pensonic Holdings
4	Apex Healthcare Bhd	43	Hup Seng Industries	82	Poh Huat Res Hldgs
5	Apollo Food Holdings	44	Hwa Tai Industries	83	Poh Kong Holdings
6	Asia Brands Bhd	45	Iq Group Hldgs	84	PPB Group Bhd
7	Asia File Corp Bhd	46	Jaycorp Bhd	85	Prolexus Berhad
8	Bio Osmo Berhad	47	Jerasia Capital Bhd	86	PWF Consolidated
9	Bonia Corporation	48	Johore Tin Berhad	87	QL Resources Bhd
10	British Amer Tobacco	49	Karex	88	Salutica
11	C.I. Holdings Berhad	50	Kawan Food Berhad	89	Sand Nisko Cap
12	Cab Cakaran Bhd	51	Khee San Berhad	90	Sasbadi Holdings Bhd
13	Caely Holdings Bhd	52	Khind Holdings	91	Saudee Group

14	Cam Resources Bhd	53	Kotra Industries Bhd	92	Sern Kou Resrcs Bhd
15	Carlsberg Brewery	54	Kuantan Flour Mills	93	SHH Resources Hldgs
16	Cck Consol	55	Latitude Tree	94	Signature Inter
17	Ccm Duopharma	56	Lay Hong Berhad	95	Sinmah Capital
18	China Ouhua	57	Lee Swee Kiat Gp	96	Spring Gallery Bhd
19	Classic Scenic Bhd	58	Lii Hen Industries	97	Spritzer Berhad
20	Cocoaland Hldgs	59	London Biscuits Bhd	98	SWS Capital Bhd
21	Cwg Holdings Bhd	60	LTKM Bhd	99	Syf Resources Bhd
22	D.B.E. Gurney	61	Magni Tech	100	Tafi Industries Bhd
23	Degem Bhd	62	Malayan Flour Mills	101	Tan Chong Motor
24	Dutch Lady Milk	63	Maxwell Inter	102	Tek Seng Holdings
25	Eka Noodles Bhd	64	Milux Corp Bhd	103	Teo Guan Lee Corp
26	Emico Holdings Bhd	65	Mintye Industries	104	Teo Seng Capital
27	Eng Kah Corporation	66	MSM Malaysia	105	Tomei Cons Bhd
28	Euro Holdings Bhd	67	Nestle (Malaysia)	106	TPC Plus Bhd
29	Eurospan Holdings	68	New Hoong Fatt	107	UMW Holdings Berhad
30	Fcw Holdings Bhd	69	Ni Hsin Resrcs Bhd	108	UPA Corp Bhd
31	Fed Furn Hldgs (M)	70	Niche Capital	109	Wang Zheng Bhd
32	Formosa Prosonic	71	NTPM Hldings Bhd	110	Xian Leng Holdings
33	Fraser & Neave	72	O&C Resources	111	Xidelang Holdings
34	G3 Global Bhd	73	Oriental Food Ind	112	Xingquan
35	Goldis Bhd	74	Oriental Holdings	113	Yee Lee Corporation
36	Guan Chong Bhd	75	Padini Holdings	114	Yoong Onn
37	Hb Global Ltd	76	Panasonic Mfg	115	YSP Southeast Asia
38	Heineken Malay	77	Paragon Union Bhd		
39	Homeritz Corp	78	Pccs Group Berhad		

The inputs used were defined as asset utilization, liquidity and leverage perspectives because they were concerned with planning and operational strategies of a firm, and profitability and growth perspective are typically considered as outputs because revenue or income generation is a major objective criterion for a firm**.** This study employs samples data of 115 consumer product companies (as shown in Table 2) listed at main board of Bursa Malaysia for the year 2015. The choice of samples data was based on availability data of all financial ratios. The data were obtained from Thomson Reuters Eikon DataStream

Data Envelopment Analysis (DEA)

DEA is a mathematical model used to measure the relative efficiency of a set of DMUs with multiple inputs and outputs without specifying a priori of a production function. Consider a set of n DMUs. For DMU k, let $y_{rk}\left(r=1,.....,s\right)$ denotes the level of the r^{th} output, and $x_{ik}\left(i=1,.....,m\right)$ denotes the level of the i^{th} input. To measure the efficiency of DMU k, the weights u_r and v_i will be found to maximize output. The value of E_k is between zero and one, with higher values indicating greater efficiency. The optimal θ satisfied $0<\theta\leq 1$. If θ equals to one, then the DMU under measurement is said to be technically efficient and lies on the efficiency frontier that composed of the set of efficient units. To measure the efficiency of DMU k, the weights u_r and v_i will be found to maximize the following ratio E_k subject to a set of constrain:

$$Max\ E_k=\sum_{r=1}^{s}u_r y_{rk} \tag{1}$$

Subject to $\sum_{r=1}^{s}u_r y_{rk}-\sum_{i=1}^{m}v_i x_{ij}\leq 0 \quad j=1,2,.....,115$

$$\sum_{i=1}^{m}v_i x_{ik}=1$$

$$u_r; v_i\geq 0 \qquad r=1,2,.....,s;\ i=1,2,.....,m$$

Linear programming for DEA-CCR model is:

$$Min\,\theta \tag{2}$$

Subject to $\theta_{xik}-\sum_{j=1}^{n}\lambda_j x_{ij}\geq 0, \quad i=1,2,.....,m$

$$\sum_{j=1}^{n}\lambda_j y_{rj}\geq y_{rk},\ r=1,2,.....,s$$

$$\lambda_j\geq 0, \quad j=1,2,.....,n \quad \theta \text{ unrestricted in sign}$$

Taking variable returns to scale into account, Banker et al., (1984) extended the model in equation (2) to obtain the following model, commonly referred to as the BCC model. The DEA-BCC model equation is as follows:

$$Min\,\theta \tag{3}$$

Subject to $\theta_{xik}-\sum_{j=1}^{n}\lambda_j x_{ij}\geq 0, \quad i=1,2,.....,m$

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

$$\sum_{j=1}^{n}\lambda_j y_{rj}\geq y_{rk}, \quad r=1,2,.....,s$$

$$\lambda_j\geq 0, \quad j=1,2,.....,n \quad \theta \text{ unrestricted in sign}$$

The objective value of BCC is said to be the pure technical efficiency (PTE). The PTE measures how a DMU utilizes the resources under exogenous environments. For total ranking of entire companies in the industry, it will be a problem when efficiency scores are calculated the

same. Therefore, we consider:

$\sum_{i=1}^{6} u_r y_{rj}$ as total revenue and $\sum_{i=1}^{2} v_i x_{ij}$ as total cost.

Balance Index is to be calculated based on the second restriction. The second restriction to get a profit for j^{th} DMU is presented as follow:

$$\left[\sum_{r=1}^{6} u_r y_{rj} - \sum_{i=1}^{2} v_i x_{ij}\right] \leq 0 \quad (4)$$

Based on equation (4), when the shadow price is derived from technology, the profit of DMU is zero. This situation is called a balanced situation. Next, Alirezaee and Afsharian (2007) have used the profit restriction and sum to describe a new index in addition to the efficiency score for each DMU. This situation is called Balance Index. Therefore, when the profit restriction by the shadow price becomes zero, we say that p^{th} DMU is efficient. When the profit for other DMUs is equal to or less than zero, the current DMU has overcome the others in this profit competition. Otherwise, the DMU is inefficient because its profit restriction is not zero, thus it is considered a loss. As a conclusion, the less the sum is, the more the profit of the evaluated DMU differs from the profits other DMUs. Thus, the higher the evaluated DMU should be ranked. Therefore, we can conclude that if the efficiency scores of DMU_A and DMU_B are the same, and at the same time, if DMU_A obtains more negative quantity value in Balance Index than DMU_B, then DMU_A has a higher rank than DMU_B. The Balance Index computed for the year 2015 is as follows:

$$= \left[6.22u_1 + 21.7u_2 + 1.33u_3 + 2660.83u_4 + 5.53u_5 + 3.67u_6\right] - \left[45.88v_1 + 113.73v_2\right] \quad (5)$$

DuPont Analysis

The DuPont analysis highlights a company's performance in three areas: profitability (net profit margin), total assets turnover and equity multiplier (leverage). Net Profit Margin (NPM) indicates how effective a company is at cost control. The higher the net profit margin of company is, the more effective the company in converting (in) revenue into actual profit. The asset utilization ratio calculates the total revenue earned for every dollar of asset a company owns. This ratio indicates a company's efficiency in using its assets. ROE reveals how much profit a company earns in comparison to the total amount of the shareholders' equity found on the balance sheet. A business that has a high ROE is more likely to be one that is capable of generating cash internally. For the most part, the higher a company's ROE to its industry, the better (Almazari, 2012). DuPont also provides management with roadmap in assessing their effectiveness in managing the company's resources so as to maximize the return earned on owners' investment. For the DuPont analysis, the value of ROE is based on the following model:

$$\begin{aligned} \text{ROE} &= \text{Net Profit Margin} \times \text{Total Asset Turnover} \times \text{Equity Multiplier} \\ &= \frac{\text{Net Profit}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Total Asset}} \times \frac{\text{Total Asset}}{\text{Total Shareholder's Equity}} \end{aligned} \quad (6)$$

Results and Discussion

The researchers applied two models in the DEA which are the DEA-CCR model and DEA-BCC model to compute the efficiency score of the companies. As a reference, efficiency score at 1 indicates the efficient companies and less than 1 indicates inefficient companies.

Table 3
Efficiency Scores using DEA Models

DMU	CCR	BCC	DMU	CCR	BCC	DMU	CCR	BCC	DMU	CCR	BCC
1	1	1	30	0.192	0.250	59	0.244	0.350	88	0.191	0.214
2	0.375	0.406	31	1	1	60	0.723	1	89	0.204	0.378
3	0.547	0.614	32	0.152	0.184	61	0.372	0.394	90	0.728	0.730
4	0	0.109	33	0.403	0.559	62	0	0.951	91	0.459	1
5	0.814	0.932	34	0	0.182	63	1	1	92	0.036	0.133
6	0.055	0.205	35	0.023	0.082	64	0.047	0.119	93	0	0.331
7	0.453	0.473	36	1	1	65	0.003	0.145	94	0.149	0.208
8	0.383	1	37	0	0.102	66	0.491	0.589	95	0.315	0.318
9	0	1	38	0.233	0.524	67	0.527	0.680	96	0.005	0.118
10	0.207	0.240	39	0.236	0.259	68	0.325	1	97	1	1
11	0.043	0.096	40	0.401	0.672	69	0.337	0.422	98	0.337	0.369
12	0.116	0.230	41	0.309	0.358	70	0.229	0.447	99	0.074	0.115
13	0.082	0.126	42	0.486	0.515	71	0.162	0.550	100	0.285	0.335
14	0.244	0.691	43	0.896	1	72	0.281	0.312	101	0	0.905
15	0.057	0.110	44	0.208	0.258	73	0	0.153	102	0.031	0.128
16	0.674	0.719	45	0.269	0.278	74	0.210	0.233	103	0.225	0.282
17	0.062	0.110	46	0.112	0.172	75	0.251	0.325	104	0.255	0.288
18	0	1	47	0.060	0.103	76	0.176	0.181	105	0.031	0.112
19	0.598	0.621	48	0.210	0.243	77	1	1	106	0.165	0.195
20	1	1	49	0.714	0.715	78	0.102	0.181	107	0	0.155
21	0.089	0.145	50	0.645	0.661	79	0	0.067	108	0.308	0.358
22	0	0.092	51	0	0.116	80	0.229	0.238	109	0.103	0.155
23	0.225	0.334	52	0.168	0.278	81	0.084	0.106	110	0.336	0.678
24	0.927	1	53	0.059	0.118	82	0.082	0.154	111	0.121	0.666
25	0	0.096	54	0.070	0.226	83	0.181	0.193	112	0.843	0.916
26	0.067	0.176	55	0.291	0.442	84	1	1	113	0.103	0.175
27	0.666	0.768	56	0.077	0.106	85	0.138	0.334	114	0.286	0.316
28	0.152	0.238	57	0.140	0.173	86	0.118	0.137	115	0.422	0.449
29	0.053	0.140	58	0.221	0.283	87	0.113	0.223			

Table 3 shows that the efficiency score of DMUs (companies) using the DEA-CCR and DEA-BCC models. The result shows that there are 8 (7%) companies that were having the same efficiency score at 1 and the rest were inefficient companies when the DEA-CCR model was employed. The efficient companies when using the DEA-CCR model are DMU63 (Maxwell Inter), DMU97 (Spritzer Berhad), DMU31 (Fed Furn Hldgs (M)), DMU84 (Poh Kong Holdings), DMU77 (Paragon Union Bhd), DMU20 (Cocoaland Hldgs), DMU36 (Guan Chong Berhad) and DMU1 (Acoustech Bhd). However, the number of efficiency companies increased to 16 (14%) companies when the BCC model was employed to the data. DMU97 (Spritzer Berhad), DMU63

(Maxwell Inter), DMU9 (Bonia Corporation), DMU18 (China Ouhua), DMU31 (Fed Furn Hldgs (M)), DMU84 (PPB Group Bhd), DMU77 (Paragon Union Bhd), DMU36 (Guan Chong Berhad), DMU20 (Cocoaland Hldgs), DMU1 (Acoustech Bhd), DMU43 (Hup Seng Industries), DMU60 (LTKM Bhd), DMU24 (Dutch Lady Milk), DMU68 (New Hoong Fatt), DMU8 (Bio Osmo Berhad) and DMU91(Saudee Group) are identified as efficient companies for the year 2015 according to the DEA-BCC model. We can also distinguish a different total number of efficient companies and efficiency score using the DEA models. When the BCC model was applied, the number of efficient companies was greater than the CCR model. The value of efficiency score for inefficient companies under the DEA-BCC model was also greater than efficiency score for inefficient companies under the DEA-CCR model. It is because of the different assumption of technology. The DEA-CCR model assumes that all the DMUs are a constant return to scale (CRS) and under the BCC model, it assumes that all the DMUs are a variable return to scale (VRS), and this is consistent with(Repkova, 2012).

Table 4 provides information about the number of times the peers of non-performing companies referred the peers of efficient companies. When the number of efficient companies were referred to by non-performing companies as a benchmark increased, those efficient companies were good at utilizing their inputs to maximize their outputs. For example, the efficient companies such as DMU20 (Cocoaland Hldgs) and DMU31 (Fed Furn Hldgs (M)) had the highest number of DMUs (peers non-performing) referred to the DEA-CCR model and DEA-BCC model respectively.

Table 4
List of Peers

DEA-CCR Model		DEA-BCC Model		DEA-BCC Model	
DMU	No. of Peers	DMU	No. of Peers	DMU	No. of Peers
63	6	97	3	20	55
97	4	63	11	1	13
31	79	9	6	43	9
84	48	18	11	60	1
77	13	31	89	24	6
20	88	84	72	68	1
36	72	77	7	8	13
1	28	36	65	91	1

Peers efficient (benchmark) unit acts as models or references for inefficient companies to improve their performance and their best practices. A linear combination of efficient peers acts as combination efficient position under evaluation. For example, under the DEA-CCR model, DMU2 was considered as an inefficient company and efficient units DMU20, DMU31, DMU63 and DMU77 were its peers, meaning that DMU2 was able to try to compete with a linear combination of these DMU20, DMU31, DMU63 and DMU77 in order to be on the performing frontier.

Ranking performance of stock using the DuPont analysis are based on calculation of ROE shown in Table 5 and Table 6. ROE was used to measure the percentage of earnings available to stockholders as per their total equity invested. By using the DuPont analysis, the company with the highest value of ROE is considered as a well-performed company because

the company can generate a high return on stockholders' investment. Investors can use the DuPont analysis to identify factors that cause the company to get a low ROE. The factors are probably due to its profitability (net profit margin), efficiency in utilizing the assets (total assets turnover) and financial leverage (equity multiplier). As shown in Table 3, the highest and lowest ranks among 115 selected companies were DMU10 (British Amer Tobacco) and DMU37 (HB Global Ltd) respectively.

Table 5
Percentage of ROE

DMU	ROE (%)	DMU	ROE (%)	DMU	ROE (%)	DMU	ROE (%)	DMU	ROE (%)
10	104.1	112	11.54	17	7.19	23	3.83	111	0.47
38	34.61	85	11.42	42	7.13	52	3.54	98	0.37
15	34.43	76	11.23	93	7.09	65	3.45	107	-0.31
24	34.20	73	11.17	109	7.01	13	3.43	105	-0.79
88	27.77	19	11.07	106	6.92	69	3.34	100	-0.89
67	27.72	40	10.53	48	6.75	92	3.11	29	-1.47
43	22.32	33	10.51	1	6.73	36	2.88	70	-1.57
30	20.86	87	10.50	56	6.67	83	2.88	91	-2.99
39	19.43	76	10.43	47	6.61	59	2.75	96	-3.25
60	18.84	114	9.98	14	6.18	51	2.52	80	-4.76
58	18.65	57	9.76	11	5.72	26	2.37	18	-7.81
104	16.41	115	9.54	102	5.68	35	2.27	95	-9.91
61	15.45	7	9.45	68	5.21	28	2.26	78	-9.97
55	15.35	5	9.28	32	5.06	79	2.15	8	-11.29
75	14.30	71	9.11	16	5.00	101	2.05	3	-11.59
94	14.21	41	8.92	21	4.98	86	2.03	63	-12.08
45	13.73	2	8.91	84	4.83	62	1.97	22	-12.14
50	13.05	31	8.84	113	4.53	77	1.62	89	-12.41
20	13.01	4	8.77	12	4.27	110	1.02	72	-14.24
82	12.62	9	8.73	46	4.19	53	0.71	34	-17.94
49	12.56	97	8.42	103	4.00	44	0.66	54	-49.40
66	11.99	108	8.39	74	3.91	64	0.57	25	-54.04
90	11.58	99	7.37	27	3.88	6	0.52	37	-80.50

Table 6
Ranking the DMUs based on DuPont and DEA Models

DMU	Rank			DMU	Rank			DMU	Rank		
	DuPont	CCR	BCC		DuPont	CCR	BCC		DuPont	CCR	BCC
1	53	8	10	40	29	28	28	79	105	112	115
2	40	30	43	41	39	37	48	80	83	51	69
3	107	20	32	42	48	23	37	81	102	81	107
4	42	102	106	43	7	10	11	82	20	82	89
5	37	12	18	44	90	57	64	83	77	62	78
6	92	92	76	45	17	43	61	84	63	4	6
7	36	25	38	46	66	76	86	85	25	71	51
8	106	29	15	47	55	89	109	86	85	73	94
9	43	103	2	48	52	56	66	87	31	75	73
10	1	58	67	49	21	15	24	88	5	61	74
11	57	95	112	50	18	18	30	89	110	59	45
12	65	74	71	51	79	109	101	90	23	13	22
13	73	83	97	52	71	64	62	91	100	24	16
14	56	47	25	53	89	90	100	92	75	96	95
15	3	91	105	54	113	86	72	93	49	113	53
16	61	16	23	55	14	39	41	94	16	69	75
17	47	88	104	56	54	84	108	95	104	36	55
18	103	104	4	57	34	70	85	96	101	100	99
19	28	19	31	58	11	54	59	97	44	2	1
20	19	6	9	59	78	46	49	98	94	33	46
21	62	80	92	60	10	14	12	99	46	85	102
22	109	105	113	61	13	31	44	100	97	41	50
23	70	52	52	62	86	110	17	101	84	114	20
24	4	9	13	63	108	1	3	102	58	97	96
25	114	106	111	64	91	94	98	103	67	53	60
26	80	87	83	65	72	101	91	104	12	44	58
27	69	17	21	66	22	22	33	105	96	98	103
28	82	67	68	67	6	21	26	106	51	65	77
29	98	93	93	68	59	35	14	107	95	115	87
30	8	60	65	69	74	32	42	108	45	38	47
31	41	3	5	70	99	50	40	109	50	78	88
32	60	68	79	71	38	66	35	110	88	34	27
33	30	27	34	72	111	42	57	111	93	72	29
34	112	107	80	73	27	111	90	112	24	11	19
35	81	99	114	74	68	55	70	113	64	77	84
36	76	7	8	75	15	45	54	114	33	40	56
37	115	108	110	76	26	63	82	115	35	26	39
38	2	49	36	77	32	5	7				
39	9	48	63	78	87	79	81				

When the DEA method's results of efficiency score are the same for both models, we were unable to rank the performance using the efficiency score. So, the Balance Index by Alirezae and Afsharian's method was computed to rank the entire companies. The ranking

result using Balance Index for both methods were compared, and it is illustrated in Table 6. The result indicated that using the DEA-CCR method, 14 DMUs could not be ranked using the values of Balance Index. This is due to the values of Balance Index for those DMUs are zero. The DMUs were DMU4, DMU9, DMU18, DMU22, DMU25, DMU34, DMU37, DMU51, DMU62, DMU73, DMU79, DMU93, DMU101 and DMU107. So, all the 14 DMUs were ranked at the bottom of the list. On the other hand, the other 102 DMUs were able to be ranked completely using the efficiency score and values of Balance Index. It can also be seen that the DMUs (companies), which have the same efficiency score under DEA-CCR model, can be ranked using the values of their Balance Index. The examples of inefficient stocks with the same efficiency scores are DMU23 and DMU103 where the efficiency score is 0.225. We reset the rank and re-ranked the DMUs based on the value of Balance Index. The ranking for DMU23 and DMU103 were at 52nd and 53th place respectively as shown in Table 5. The result indicated the Alirezae and Afharian's ranking method is unstable through the DEA-CCR model approach because it failed to rank all 115 companies.

However, the DEA-BCC model's result showed that all of the selected companies were successfully and completely ranked based on the ranking method of Balance Index The result indicated the Alirezae and Afharian's ranking method was unstable through the DEA-CCR model approach because it failed to rank all 115 companies. We can also see that three different approaches produced different ranking results shown in Table 6. For example, the top-ranked company based on the DEA-CCR model, DEA-BCC model and DuPont analysis were DMU63 (Maxwell Inter), DMU97 (Spritzer Berhad) and DMU10 (British Amer Tobacco) respectively. DMU10 had the highest ROE (ROE: 104.1%; NPM: 19.86%; assets turnover: 3.89; debt usage (equity multiplier): 1.35) followed by DMU63 (ROE: -12.08%; NPM: -33.56%; asset turnover: 0.36; debt usage (equity multiplier):1) and DMU97 (ROE: 8.42%; NPM: 8.99%; asset turnover: 0.81; debt usage (equity multiplier): 1). DMU10's profitability was higher than DMU63 and DMU97, as shown by net profit margin. DMU10 was also more efficient in managing its assets due to higher total assets turnover ratio compared to DMU63 and DMU97.

Profitability of DMU63 was lower than DMU97, where DMU63 incurred a loss a 12.08%. On the other hand, DMU97 was ranked at 44th and DMU63 ranked at 108th using the DuPont analysis. Hence, the DuPont analysis enables decision makers to have a clearer view of factors influencing the ROE and the inter-relationship between net profit margin, assets turnover and debt level of a company. Regarding the three different approaches in ranking the companies, we continued with the hypothesis testing and computed the Spearman rank correlation. This hypothesis testing was conducted to identify the correlation among ranking-based on DuPont and DEA-CCR, DuPont and DEA-BCC, DEA-CCR and DEA-BCC models. The correlation coefficient ranking between DuPont and DEA-CCR, DuPont and DEA-BCC, DEA-CCR and DEA-BCC methods were 0.376, 0.243 and 0.766 respectively with all the p-value were less than significance level. Therefore, null hypothesis was rejected, and we concluded that there is a correlation between DuPont and DEA-CCR model, DuPont and DEA-BCC, DEA-CCR and DEA-BCC. There are also have a strong relationship between for both DEA, (CCR and BCC).

Conclusion

The findings of this study indicated that the DEA-CCR model, DEA-BCC model and DuPont analysis gave different pictures of performance analysis. The DuPont analysis is the best

measurement tool to be utilized if the decision makers use the highest return on earnings to shareholders as the main factor. In addition, the analysis also provided an indication whether a company can earn a higher return; if it generates a high net profit margin, if it uses its assets effectively to generate more sales and if it has high financial leverage. Conversely, both DEA models (CCR and BCC) give a complete analysis to decision makers since these methods are able to analyse multiple inputs and outputs. The advantages of the DEA method are the ability to create prospective improvements for inefficiency units and identify the units for benchmarking. DEA also does not require information about the process or relationship between input and output. Therefore, DEA is more flexible as compared to those parametric approaches. Additionally, DEA-BCC model is a more practical method because the assumption of the variable to scale provides more realistic situation in the economic field as compared DEA-CCR model.

However, there are limitations when conducting the study on the DEA methods for analysing stock performance. Limitations of the study need to be identified in order to give suggestions for future research. One of the limitations of DEA is that it could not distinguish between technical inefficiency and statistical noise effects. In DEA specifications, it assumes all deviations from the efficient frontier are under the control of the agent. But some situations are out of the agent's control that also can determine the sub-optimal performance of units. Regulatory-competitive environments, weather, luck, socio-economic, demographic factors and uncertainties should not properly be considered as technical efficiency. In addition, the study focused on production, so it has a relation of stochastic nature. Therefore, if this situation is ignored, the efficiency calculation outcomes will be biased thus give misleading conclusions. For future research, other researchers should consider the Stochastic Frontier Analysis (SFA) in evaluating financial efficiency performance and future researchers should attempt handling and analysing the losses situation in companies. This will be problematic if the company incurs losses (negative value) in the samples data since the logarithmic of non-negative numbers could not be defined.

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References

Alirezaee, M. R., & Afsharian, M. (2007). A complete ranking of DMUs using restrictions in DEA models. *Applied Mathematics and Computation*, *189*(2), 1550–1559.

Almazari, A. A. (2012). Financial performance analysis of the Jordanian Arab bank by using the DuPont system of financial analysis. *International Journal of Economics and Finance*, *4*(4), 86–94.

Arsad, R., Abdullah, N. M., Alias, S., & Isa, Z. (2017). Selection Input Output by Restriction Using DEA Models Based on a Fuzzy Delphi Approach and Expert Information. *Journal of Physics: Conference Series*, *892*(1). https://doi.org/10.1088/1742-6596/892/1/012010

Azadeh, A., Haghighi, S. M., Zarrin, M., & Khaefi, S. (2015). Performance evaluation of Iranian electricity distribution units by using stochastic data envelopment analysis. *International Journal of Electrical Power & Energy Systems*, *73*, 919–931.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*(9), 1078–1092.

Bulgurcu, B. (Kiran). (2012). Application of TOPSIS Technique for Financial Performance Evaluation of Technology Firms in Istanbul Stock Exchange Market. *Procedia - Social and Behavioral Sciences*, *62*, 1033–1040. https://doi.org/10.1016/j.sbspro.2012.09.176

Burja, V., & Marginean, R. (2014). The study of factors that may influence the performance by the Dupont analysis in the furniture industry. *Procedia Economics and Finance*, *16*, 213–223.

Chang, K. J., Chichernea, D. C., & HassabElnaby, H. R. (2014). On the DuPont analysis in the health care industry. *Journal of Accounting and Public Policy*, *33*(1), 83–103.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*(6), 429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Chen, H. (2008). Stock selection using data envelopment analysis. *Industrial Management & Data Systems*, *108*(9), 1255–1268.

Delen, D., Kuzey, C., & Uyar, A. (2013). Measuring firm performance using financial ratios: A decision tree approach. *Expert Systems with Applications*, *40*(10), 3970–3983. https://doi.org/10.1016/j.eswa.2013.01.012

Farrell, M. J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society. Series A (General)*, *120*(3), 253–281.

Jha, S., Hui, X., & Sun, B. (2013). Commercial banking efficiency in Nepal: Application of DEA and Tobit model. *Information Technology Journal*, *12*(2), 306–314.

Kijewska, A. (2016). Determinants of the return on equity ratio (ROE) on the example of companies from metallurgy and mining sector in Poland. *Metalurgija*, *55*(2), 285–288.

Lee, A., Lin, M., & Kao, R. (2010). An effective clustering approach to stock market prediction. *PACIS 2010 Proceedings*, 345–354.

Lin, B., & Yang, L. (2014). Efficiency effect of changing investment structure on China' s power industry. *Renewable and Sustainable Energy Reviews*, *39*, 403–411.

Ling, O. P., & Kamil, A. A. (2010). Data envelopment analysis for stocks selection on Bursa Malaysia. *Archives of Applied Science Research*, *2*(5), 11–35.

Mansouri, A., Naser, E., & Ramazani, M. (2014). Ranking of companies based on TOPSIS-DEA approach methods (case study of cement industry in Tehran stock exchange). *Pakistan Journal of Statistics and Operation Research*, *10*(2), 189–204.

Mohamad, N. H., & Said, F. (2010). Measuring the performance of 100 largest listed companies in Malaysia. *African Journal of Business Management*, *4*(14), 3178–3190.

Mokhtar, M., Shuib, A., & Mohamad, D. (2014). Identifying the critical financial ratios for stocks evaluation: A fuzzy delphi approach. *AIP Conference Proceedings*, *1635*(1), 348–354.

Muchtar, D., Nor, M. F., Albra, W., Arifai, M., & Ahmar, A. S. (2018). Dynamic performance of Indonesian public companies: An analysis of financial decision behavior. *Cogent Economics & Finance*, *6*(1), 1488343.

Murillo-Zamorano, L. R. (2004). Economic efficiency and frontier techniques. *Journal of Economic Surveys*, *18*(1), 33–77. https://doi.org/10.1111/j.1467-6419.2004.00215.x

Niaki, S., & Salmani, S. H. (2016). Using Stochatic Frontier Function to Measure Branch Efficiency of Saman Bank in Iran. *International Journal of Humanities and Cultural Studies, Special Issue*, 659–673.

Kaya, O. E. (2016). Financial Performance Assessment of Non-Life Insurance Companies Traded in Borsa Istanbul via Grey Relational Analysis. *International Journal of Economics and Finance*, *8*(4), 277. https://doi.org/10.5539/ijef.v8n4p277

Poh, L. T., Kilicman, A., & Ibrahim, S. N. I. (2018). On intellectual capital and financial performances of banks in Malaysia. *Cogent Economics & Finance*, *6*(1), 1453574.

Powers, J., & McMullen, P. (2000). Using data envelopment analysis to select efficient large market cap securities. *Journal of Business and Management*, *7*(2), 31–42.

Řepková, I. (2012). Measuring the efficiency in the Czech banking industry: Data Envelopment Analysis and Malmquist index. *Mathematical Methods in Economics.[Proceedings of 30th International Conference.] Karviná: Silesian University, School of Business Administration*, 781–786.

Rezaei, M., & Ketabi, S. (2016). Ranking the banks through performance evaluation by integrating fuzzy AHP and TOPSIS methods: A study of Iranian private banks. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, *6*(3), 19–30.

Sengul, U., & Eren, M. (2014). An Alternative Dynamic SBM Measure: A Case of the Information Technology Sector in Turkey. *Review of European Studies*, *6*(3), 81–90.

Sheela, S. C. (2020). *Financial Performance of Pharmaceutical Industry in India using DuPont Analysis*. *4*(14), 84–91.

Soliman, M. T. (2008). The use of DuPont analysis by market participants. *The Accounting Review*, *83*(3), 823–853.

Sweiti, I., & Lele, U. (2016). Impact of Balanced Scorecard Implementation on Financial Performance of Saudi Listed Companies. *Journal of Behavioural Economics Journal of Behavioural Economics Finance , Entrepreneurship , Accounting and Transport*, *4*(1), 8–12. https://doi.org/10.12691/jbe-4-1-2

Tsolas, I. E. (2013). Modeling profitability and stock market performance of listed construction firms on the Athens Exchange: Two-stage DEA approach. *Journal of Construction Engineering and Management*, *139*(1), 111–119.

Zamani, L., Beegam, R., & Borzoian, S. (2014). Portfolio selection using Data Envelopment Analysis (DEA): A case of select indian investment companies. *International Journal of Current Research and Academic Review*, *2*(4), 50–55.

Zohdi, M., Marjani, A. B., Najafabadi, A. M., Alvani, J., & Dalv, M. R. (2012). Data envelopment analysis (DEA) based performance evaluation system for investment companies: Case study of Tehran Stock Exchange. *African Journal of Business Management*, *6*(16), 5573–5577.