

Analyzing Listed Indonesian Securities Companies' Performance Using Data Envelopment Analysis

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This study attempts to investigate the sensitivity of Data Envelopment Analysis (DEA) relative efficiencies to various inputs and output variable combinations measured for the year 2008 of the eight securities companies listed in Indonesia Stock Exchange (IDX), modeling performance measurement and to benchmark the efficient companies against the non-efficient companies. The results suggest that PT. HD Capital Tbk, PT. Panin Sekuritas Tbk and PT. Trimegah Securities Tbk are 100% efficient in both global technical efficiency and pure technical efficiency amid the enduring global financial crisis. The features of efficient peer companies make them very useful as role models that inefficient companies can emulate to improve their performance.

Key words: CRS-input, data envelopment analysis, decision making unit, efficiency, Indonesia, non-bank financial institution, performance evaluation, securities companies, VRS-input

INTRODUCTION

The Indonesian securities companies as one of several non-bank financial institutions (NBFIs) contribute insignificantly to local stock market activity compared to other NBFIs (World Bank, 2006), but due to its academic and practical importance, securities companies' performance assessment has been an important area of research in finance. Thus, there are very good reasons to perform studies on securities companies in parallel with the banking system with regards to their efficiency and productivity. This present study provides significant contributions to the performance field and to all securities companies in Indonesia.

The two main functions of securities companies according to Burton et al. (2003:451) are: (1) investment banking deals with the marketing of newly issued securities in the primary market, (2) brokers and dealers assist in the marketing of previously issued securities in the secondary market. The present study was designed to investigate the sensitivity of the Data Envelopment Analysis (DEA) relative efficiencies to various inputs and output variable combinations measured for the year 2008 of the eight securities companies listed in Indonesia Stock Exchange (IDX), modeling performance measurement and to benchmark the efficient companies against the non-efficient companies. The study attempts to have significant and original contributions to the performance measurement field, to open new areas of future research in efficiency analysis using DEA. The result of this study will help the Bapepam-LK (Badan Pengawas Pasar Modal dan Lembaga Keuangan) or

Indonesia Capital Market and Financial Institution Supervisory Agency to insist those inefficient companies to take quick actions to avoid more serious inefficiency problems and to be able to protect investors from losses caused by inefficient securities companies listed on IDX. Investors can also use this study to analyze and evaluate the companies' performance and to give information in their investment decisions. The result of this study will enable management of the securities companies to take quick actions and to make progress on the operations to gain competitive advantage. Creditors can use this study to analyze and evaluate loan applications. This study may also serve as a framework for an approach that is different from the common traditional approach on financial performance measurement. The research findings may also serve as a guide and direction in policy making, planning, programming and implementing actions not only for the securities companies but also for other industries, especially on cost-savings of resource allocation the principal consideration on the selection of the sector in the study is the availability of data and sample homogeneity. The period of 2008 was considered in which the global crisis that peaked in 2008 demonstrated high volatility makes this study more interesting. This study addresses the question: Which company is more efficient in converting inputs into outputs. Three (3) inputs and one output variable were used and entered into the DEA model for efficiency analysis. The data were extracted from the audited financial statements published by Indonesia stock exchange (IDX).

Review of Related Literature. In the past few years, a number of researches have been

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conducted to explore the use of DEA in financial service industries. DEA has frequently been applied to banking industry studies and several non-bank financial institutions. Conceição et al. (2005) examined, using a DEA model, the profitability of a sample of Portuguese bank branches. Their study concentrated on reported profitability, current deposits, and net interest revenue. They identified profit improvement differentials in the short and the long run. Grigorian and Manole (2006) studied banking sectors in transition economies during the 1990s. They estimated indicators of commercial bank efficiency in various transition countries. The finding shows that foreign ownership and consolidation were important factors in enhancing efficiency. As driver variables they used: net interest margin, noninterest income as a ratio to assets, return on assets and return on equity. Lo and Lu (2006) concentrated on the analysis of size as it relates to efficiency. They used as their study variables: total assets, total equity, employees, revenue, profit and a series of financial market measures. They reported that size is a major factor in differentiating efficiency-profiles for the financial holding companies studied.

Khalaf Al-Delaimi and Battall Al-Ani (2006), using DEA to measure cost efficiency with an application on Islamic banking. This study shows that most Islamic banking institutions which are the sample of the study are efficient and the rest is on the way of improving their efficiencies. Mostafa (2007) used DEA method to evaluate the relative efficiency of Arab banks and the results indicate that the performance of several banks is sub-optimal, suggesting the potential for significant improvements. Separate benchmarks were derived for possible reductions in resource used, and significant savings are possible on this account. Lin and Huang (2009) used DEA in studying the optimal size of the financial services industry in Taiwan and the results suggest a great potential for restructuring of the financial services industry in Taiwan. Saad and El-Moussawi (2009) evaluated the productive efficiency of Lebanese commercial banks. The empirical results show that the process of restructuring the Lebanese banking sector has been accompanied by an improvement of the cost efficiency of Lebanese banks. Ahmed and Faroog (2009) used the output-oriented model of DEA to put much weight on the expansion of output quantity out of given amount of inputs. Overall conclusion of the study is that financial sector reforms are successful in improving the efficiency of the domestic commercial banks role as intermediations in Pakistan. Ravichandran et al. (2009) applied DEA for analyzing the efficiency of market based bank mergers in India. Empirical research was carried out on seven Indian banks and found that merger and acquisition has greater

impact on banking efficiency.

Fukuyama and Weber (2008) developed a new indicator of profit inefficiency, which is based on decision-makers, choosing the amount to spend on each input and the amount to earn on each output, rather than choosing physical quantities of inputs and outputs. They offer an empirical example of their method using firms in the Japanese securities industry during the period 1989-2005. They find profit inefficiency rises from 1989 to 1993, declines during the 1994-2001 period, and then increases during the years 2002-2005. Lost profits as a percent of assets range from 0% to 15% and are highest in 2002-2005.

In summary, these previous studies offer significant contributions in providing a benchmark for modeling performance measurement of the securities companies using DEA method. Evidence shows that this technique is widely acknowledged and extensively applied in financial service industries. As illustrated above, there is only one study that specifically deals with securities companies (Fukuyama and Weber, 2008). Therefore, this study extends previous literature by providing financial statement analysis of the securities companies a point in time when the industry is going through much turmoil during the global financial crisis.

DATA SAMPLE AND METHODOLOGY

For the empirical analysis, all Indonesian securities companies listed in Indonesia Stock Exchange (IDX) as of 2008 incorporated in the study. Table 1 shows the Decision Making Units (DMUs) that represent all the securities companies. The primary considerations in the selection of firms in this study are data availability and sample homogeneity. The data were sourced out from the published annual financial reports of the eight companies that are publicly available from IDX. The relative efficiency by which the securities companies utilize their inputs is reflected on the output factors they have produced. These variables are analyzed through the input-oriented DEA model. This study used three (3) inputs and one (1) output variables. The input variables of the DMUs measured were: (1) total equity; (2) operating expenses; (3) salaries and benefits. These input variables mentioned are the resources that have been utilized to produce a firm's output. Outputs represent those goods or services, which the clients of the companies are prepared to purchase, and the sale of these outputs generates revenue. The output variable used in the study is total revenues.

The term Data Envelopment Analysis (DEA) was first introduced by Charnes, Cooper and Rhodes (1978), (hereafter CCR), to measure the efficiency of each Decision Making Unit (DMU), that is obtained as a maximum of a ratio of

weighted outputs to weighted inputs. This denotes that the more the output produced from given inputs, the more efficient is the production. The weights for the ratio are determined by a restriction that the similar ratios for every DMU have to be less than or equal to unity. This definition of efficiency measure allows multiple outputs and inputs without requiring pre-assigned weights. Multiple inputs and outputs are reduced to single 'virtual' input and single 'virtual' output by optimal weights. The efficiency measure is then a function of multipliers of the 'virtual' input-output combination.

The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming constant returns to scale (CRS) and it delivers the overall technical efficiency (TE). The CRS assumption is only justifiable when all DMUs are operating at an optimal scale. However, firms or DMUs in practice might face either economies or diseconomies of scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of technical efficiency will be contaminated with scale efficiencies.

Banker et al. (1984) extended the CCR model by relaxing the CRS assumption. The resulting "BCC" model was used to assess the efficiency of DMUs characterized by variable returns to scale (VRS). The VRS assumption provides the measurement of pure technical efficiency (PTE), which is the measurement of technical efficiency devoid of the scale efficiency effects. If there appears to be a difference between the TE and PTE scores of a particular DMU, then it indicates the existence of scale inefficiency.

Three useful features of DEA are first, each DMU is assigned a single efficiency score, hence allowing ranking amongst the DMUs in the sample. Second, it highlights the areas of improvement for each single DMU. For example, since a DMU is compared to a set of efficient DMUs with similar input-output configurations, the DMU in question is able to identify whether it has used input excessively or its output has been under-produced. Finally, there is possibility of making inferences on the DMUs general profile. We should be aware that the technique used here is a comparison between the production performances of each DMU to a set of efficiency DMUs. The set of efficiency DMUs is called the reference set. The owners of the DMUs may be interested to know which DMU frequently appears in this set. A DMU that appears more than others in this set is called the global leader. Clearly, this information gives huge benefits to the DMU owner, especially in positioning its entity in the market.

The main weakness of the DEA is that it

assumes data are free from measurement errors. Furthermore, since efficiency is measured in a relative way, its analysis is confined to the sample set used. This means that an efficient DMU found in the analysis cannot be compared with other DMUs outside of the sample. The reason is simple. Each sample, separated, let us say, by year, represents a single frontier, which is constructed on the assumption of same technology. Therefore, comparing the efficiency measures of a DMU across time cannot be interpreted as technical progress but rather has to be taken as changes in efficiency (Canhoto and Dermine, 2003).

DEA can be used to derive measures of scale efficiency by using the variable returns to scale (VRS), or the BCC model, alongside the constant returns to scale (CRS), or the CCR model. A DEA model can be constructed either to minimize inputs or to maximize outputs. An input orientation aims at reducing the input amounts as much as possible while keeping at least the present output levels, while an output orientation aims at maximizing output levels without increasing use of inputs (Cooper et al., 2004). As we are looking at relative efficiency, it is important for the DMUs to be sufficiently similar, so that comparisons are meaningful. This is particularly the case with DEA, where Dyson et al. (2001) have developed what they describe as a series of homogeneity assumptions. The first of these is that the DMUs the performance of which is being compared should be undertaking similar activities and producing comparable products and services so that a common set of outputs can be defined. The second homogeneity assumption is that a similar range of resources is available to all the units and they operate in a similar environment.

In this study, the comparative evaluation among the companies is an important consideration. Therefore, the envelopment model for analysis is selected. In addition, the outputs are an outcome of managerial goals. Therefore, input-based formulation is recommended for this study. Furthermore, to investigate the affect of scale of operations, if any among the eight companies, constant return to scale (CRS) and variable returns to scale (VRS) DEA models are considered. The comparisons of the input-oriented CCR and BCC scores are considered in this study. The CCR model assumes the constant returns to scale (CRS) production possibility set, i.e., it is postulated that the radial expansion and reduction of all observed DMUs and their nonnegative combinations are possible and hence the CCR score is called global technical efficiency. On the other hand, the BCC model assumes the convex combinations of the observed DMUs as the production possibility set and the BCC score is called local pure technical efficiency. If a DMU is fully efficient (100%) in both the CCR and BCC scores, it is operating in the

most productive scale size. Efficiency scores range from 0 to 1; whereby, a score of 1 represents 100% efficiency. The CCR score is called the (global) technical efficiency (TE), since it takes no account of scale effect. On the other hand, the BCC expresses the (local) pure technical efficiency (PTE) under variable returns-to-scale circumstances. (Cooper, Seiford & Tone, 2004).

In the input-oriented model, the technical efficiency of a firm can be represented by the amount by which all inputs could be proportionally reduced without a reduction in output. This is usually expressed in percentage terms, which represents the percentage by which all inputs need to be reduced to achieve technically efficient production. Constant Returns to Scale implies that a change in the amounts of the inputs leads to a similar change in the amounts of the outputs. Variable returns to Scale is able to distinguish between technical and scale inefficiencies. The input-oriented CCR model attempts to minimize inputs while producing at least the given output levels:

$$(DLP_o) \min \theta$$

$$\text{Subject to } \theta x_o - X\lambda \geq 0; \quad Y\lambda \geq y_o; \quad \lambda \geq 0 \quad (1)$$

where θ is efficiency score, λ is the reference set. The input-oriented BCC model evaluates the efficiency of DMU_o ($o = 1, \dots, n$) by solving the following (envelopment form) linear program:

$$(BCC_o) \min \theta_B$$

$$\text{Subject to } \theta_B x_o - X\lambda \geq 0; \quad Y\lambda \geq y_o; \quad e\lambda = 1 \quad \lambda \geq 0 \quad (2)$$

where θ_B is a scalar. If a DMU has the full BCC efficiency but a low CCR score, then it is operating locally efficiently but not globally efficiently due to the scale size of the DMU. Thus, it is needed to characterize the scale efficiency of a DMU by the ratio of the two scores. The scale efficiency is defined by:

$$SE = \frac{\theta^* CCR}{\theta^* BCC} \quad (3)$$

Table 1. Actual Financial Data for 2008 of the Securities Companies

DMU No.	DMU	Input			Output
		Total Equity	Operating Expenses	Salaries & Benefits	Total Revenues
1	PT. Asia Kapitalindo Securities Tbk	69,472	13,920	5,017	13,922
2	PT. HD Capital Tbk	136,652	242,807	7,937	85,652
3	PT. Kresna Graha Sekurindo Tbk	116,493	53,555	18,407	62,703
4	PT. Panca Global Securities Tbk	91,573	8,397	4,237	22,619
5	PT. Panin Sekuritas Tbk	303,673	41,880	10,321	173,891
6	PT. Reliance Securities Tbk	133,918	27,329	9,759	44,995
7	PT. Trimegah Securities Tbk	381,797	193,352	104,910	288,878
8	PT. Yulie Sekurindo Tbk	49,053	4,133	1,085	876

Note: All figures are in Rp millions

Empirical Results. During the period of study, the results from Table 2 using DEA-CRS input assumption shows the relative performance of the securities companies benchmarked against each other. Three out of eight companies were ranked as efficient in 2008, and five companies were inefficient companies. PT. HD Capital Tbk, PT. Panin Sekuritas Tbk and PT. Trimegah Securities Tbk are 100% efficient. On the other hand, PT. Asia Kapitalindo Securities Tbk, PT. Kresna Graha Sekurindo Tbk, PT. Panca Global Securities Tbk, PT. Reliance Securities Tbk and PT. Yulie Sekurindo Tbk are inefficient.

The score is presented in percentage value varying between 0% and 100%. It is found that the input efficiency of PT. HD Capital Tbk, PT. Panin Sekuritas Tbk and PT. Trimegah Securities Tbk is 100%. On the other hand, the input efficiency of the remaining companies is: PT. Asia Kapitalindo Securities Tbk (33.29%), PT. Kresna Graha Sekurindo Tbk (80.30%), PT. Panca Global Securities Tbk (64.88%), PT. Reliance Securities Tbk (55.77%) and PT. Yulie Sekurindo Tbk (5.1%).

This means that the observed levels of total revenues for PT. Asia Kapitalindo Securities Tbk can be achieved with 33.29% of the current levels of total equity, operating expenses and salaries and benefits. The same rational applies to PT. Kresna Graha Sekurindo Tbk, PT. Panca Global Securities Tbk, PT. Reliance Securities Tbk and PT. Yulie Sekurindo Tbk.

Table 2 illustrates also the peer group for the inefficient companies using CRS Input. PT. HD Capital Tbk, PT. Panin Sekuritas Tbk and PT. Trimegah Securities Tbk serve as peer for PT. Asia Kapitalindo Securities Tbk, PT. Kresna Graha Sekurindo Tbk and PT. Reliance Securities Tbk. Finally, PT Panin Sekuritas Tbk serves as the closest peer for PT. Panca Global Securities Tbk and PT. Yulie Sekurindo Tbk. Imperfect competition constraints on finance, etc. may cause a DMU to be not operating at optimal scale. Banker at al. (1984) suggests an extension of the CRS-DEA model to account for variable returns to scale (VRS) situations. The use of the CRS specification when not all DMU's are operating at the optimal

scale will result in measure of technical efficiency (TE) which is confounded by scale efficiency (SE).

The use of the VRS specification will permit the calculation of TE devoid of these SE effects.

Table 2. Efficiency Summary DEA Efficiency Scores & Rankings – CRS Input

DMU No.	Bank (DMU Name)	Efficiency Score	DEA Rankings	Reference Set
1	PT. Asia Kapitalindo Securities Tbk	0.332926	7	2, 5, 7
2	PT. HD Capital Tbk	1.000000	1	2
3	PT. Kresna Graha Sekurindo Tbk	0.802955	4	2, 5, 7
4	PT. Panca Global Securities Tbk	0.648752	5	5
5	PT. Panin Sekuritas Tbk	1.000000	1	5
6	PT. Reliance Securities Tbk	0.557669	6	2, 5, 7
7	PT. Trimegah Securities Tbk	1.000000	1	7
8	PT. Yulie Sekurindo Tbk	0.051047	8	5

As shown in Table 3, when VRS input was assumed only PT. Asia Kapitalindo Securities Tbk (92.51%) and PT. Reliance Securities Tbk (80.84%) were below the efficient frontier. The rest of the companies were operating on an efficient level under VRS. PT. Kresna Graha Sekurindo Tbk, PT.

Panin Sekuritas Tbk, PT. Trimegah Securities Tbk and PT. Yulie Sekurindo Tbk serve as the closest peers for PT. Asia Kapitalindo Securities Tbk and PT. Reliance Securities Tbk and appear to be the global leaders.

Table 3. Efficiency Summary DEA Efficiency Scores & Rankings – VRS Input

DMU No.	Bank (DMU Name)	Efficiency Score	DEA Rankings	Reference Set
1	PT. Asia Kapitalindo Securities Tbk	0.925106	7	3, 5, 7, 8
2	PT. HD Capital Tbk	1.000000	1	2
3	PT. Kresna Graha Sekurindo Tbk	1.000000	1	3
4	PT. Panca Global Securities Tbk	1.000000	1	4
5	PT. Panin Sekuritas Tbk	1.000000	1	5
6	PT. Reliance Securities Tbk	0.808448	8	3, 5, 7, 8
7	PT. Trimegah Securities Tbk	1.000000	1	7
8	PT. Yulie Sekurindo Tbk	1.000000	1	8

A summary of calculated efficiency measures is presented in Table 4. It shows that Indonesian securities companies have exhibited mean global efficiency of 67.42% percent and higher pure technical efficiency and scale efficiency of 96.67% and 69.41%. A difference between CRS and VRS technical efficiency scores indicates that the DMU has scale inefficiency. The scale efficiency score is, therefore, the ratio between the TECRS and TEVRS scores. Mean TECRS of 67.42% for all firms indicates that firms can increase their inputs by 32.58% in 2008 and still produce the same level of output when adjusted for firm size. It is clear that PT. Asia Kapitalindo Securities Tbk and PT. Reliance Securities Tbk have higher level of pure technical efficiency (TEVRS) than TECRS but they

are not of the correct size of operation to ensure maximum total efficiency. The mean scale efficiency level of 69.41% indicates that the average firm is 30.59% scale inefficient.

PT. HD Capital Tbk, PT. Panin Sekuritas Tbk and PT. Trimegah Securities Tbk are fully efficient (100%) in both the global technical efficiency (CCR) and pure technical efficiency (BCC) scores. This result indicates that they were operating in the most productive scale size. While PT. Kresna Graha Sekurindo Tbk, PT. Panca Global Securities Tbk and PT. Yulie Sekurindo Tbk were operating locally efficiently but not globally efficiently since they have the full BCC efficiency but a low CCR score due to the scale size.

Table 4. Efficiency Summary Input Oriented DEA 2008

DMU No.	Bank (DMU Name)	Technical Efficiency (TECRS)	Pure Technical Efficiency (TEVRS)	Scale Efficiency (SE)
1	PT. Asia Kapitalindo Securities Tbk	0.332926	0.925106	0.359879
2	PT. HD Capital Tbk	1.000000	1.000000	1.000000
3	PT. Kresna Graha Sekurindo Tbk	0.802955	1.000000	0.802955
4	PT. Panca Global Securities Tbk	0.648752	1.000000	0.648752
5	PT. Panin Sekuritas Tbk	1.000000	1.000000	1.000000
6	PT. Reliance Securities Tbk	0.557669	0.808448	0.689802
7	PT. Trimegah Securities Tbk	1.000000	1.000000	1.000000
8	PT. Yulie Sekurindo Tbk	0.051047	1.000000	0.051047
	Mean	0.674169	0.966694	0.694054

CONCLUSION

Traditional financial statement analysis techniques use ratio analysis to compare a firm's performance against its peers in the industry as well as against the company's historical performance. On the basis of this comparison, analyst will recommend whether the company is doing well or underperforming relative to its peers or relative to its own past performance. DEA employs relative efficiency, a concept enabling comparison of companies with a pool of known efficient companies. The DEA model compares a firm with the pool of efficient companies by creating an efficiency frontier of good Companies. Lying beyond this boundary can improve one of the input values without worsening the others. The Data Envelopment Analysis (DEA) methodology has allowed researcher to distinguish between three different types of efficiency, such as technical, pure technical and scale efficiencies.

This study attempts to investigate the efficiency of Indonesian securities companies listed in Indonesia Stock Exchange (IDX) as of 2008. It is found that PT. HD Capital Tbk, PT. Panin Sekuritas Tbk and PT. Trimegah Securities Tbk are 100% efficient in both global technical efficiency and pure technical efficiency amid the enduring global financial crisis. The features of efficient peer companies make them very useful as role models that inefficient companies can emulate to improve their performance. A further investigation would be the examination of performance over time (panel data) by using the DEA methodology. Such an approach would allow a dynamic view of the multidimensional performance of securities companies. It is also hoped that the method used in this study can bring about other related research in other industries.

REFERENCES

- Ahmed, U. and Farooq, S. (2009). Efficiency dynamics and financial reforms: Case study of Pakistani banks. *International Research Journal of Finance and Economics*, **25**, 172-182.
- Banker, R. D., Charnes, R. F. and Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, **30**, 1078-1092.
- Burton, M., Nesiba, R., Lombra, R. (2003). *An introduction to financial markets and institutions*. USA: Thomson.
- Canhoto, A. and Dermine, J. (2003), A Note on Banking Efficiency in Portugal: New Vs. Old Banks. *Journal of Banking and Finance* **27 (11)**, 2087-2098.
- Charnes, A., Cooper, W. and Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, **2**, 429-444.
- Conceicãõ, M., Portela, A., and Thanassoulis, E. (2005), "Profitability of a sample of Portuguese bank branches and its decomposition into technical and allocative components", *European Journal of Operational Research*, **162(3)**, 850-866.
- Cooper, W.W., Seiford, L.M., & Tone, K. (2004). *Data envelopment analysis: A comprehensive text with models, applications, references and DEA-Solver software*. Boston, MA: Kluwer Academic Publishers.
- Dyson, R.G., Allen, R., Camanho, A.S., Podinovski, V.V., Sarrico, C.S. and Shale, E.A. (2001), Pitfalls and Protocols in DEA, *European Journal of Operational Research*, **132 (2)**, 245-259.
- Fukuyama, H. and Weber, W. L. (2008). Profit inefficiency of Japanese securities firms. *Journal of Applied Economics*, **XI(2)**, 281-303.
- Grigorian, D. and Manole, V. (2006), "Determinants of commercial bank performance in transition: an application of data envelopment analysis", *Comparative Economic Studies*, **48**, 497-522.
- Khalaf Al-Delaimi, K. S. and Battall Al-Ani, A. H. (2006). Using data envelopment analysis to measure cost efficiency with an application on Islamic banking. *Scientific Journal of Administrative Development*, **4**, I.A.D., 134-156.
- Lin, L. and Huang, C. Y. (2009). Optimal size of the financial services industry in Taiwan: A new DEA-option-based merger simulation approach. *The Service Industries Journal*, **29(4)**, 523-537.
- Lo, S. F. and Lu, W. M. (2006). Does size matter? Finding the profitability and marketability benchmark of financial holding companies. *Asia Pacific Journal of Operational Research*, **23(2)**, 229-246.
- Mostafa, M. (2007). Benchmarking top Arab banks' efficiency through efficient frontier analysis. *Industrial Management & Data Systems*, **107(6)**, 802-823.
- Ravichandran, K., Abdullah Alkathlan, K., Mat-Nor, F. and Mohd-Said, R. (2009). Performance of market based mergers in Indian banking institutions: An empirical study using DEA analysis. *Review of Business Research*, **9(5)**, 136-144.